graph and carbon paper and may cause them to tear under the stylus.

The turn-table used in this model has a 5½ in. radius and the circle inscribed by the stylus is 4¼ in. in diameter. These dimensions were limited by the strength of the clockwork and the availability of large sheets of paper and carbon. However, it should be noted that the larger one makes the circle inscribed by the stylus and, thus, the turn-table, the more accurate and easy it is to interpret the recorded trace.

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A SIMPLE RECORDING WIND GAUGE

II. INTERPRETING THE RECORDED WIND TRACE

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INTRODUCTION. The principle and mechanism of this apparatus have been described in the preceding paper, Part I. (Giglioli, 1964). However, since the record obtained consists of a circular graph (Fig. 5) with no scale and only a marginal note indicating the time and place the record began, it is necessary to have an overlay to interpret the results and their chronology during the 24 hours of the record.

THE RECORDED TRACE. 1. *Removal from the Gauge* (Fig. 1). After lifting the stylus the turn-table is removed from the gauge and the retaining spring loop holding the paper record and carbon overlay slipped off. Both papers are taken off the turn-table (tt.) and the carbon paper (cp.) peeled off the underlying record (r.). Four representative examples of these records are shown in Figure 5 where a circular trace of radially disposed fused arcs can be seen, often separated by sectors connected by only a single trace. The latter are produced when the wind falls below Beaufort Force I.

2. *The Trace* (Fig. 5A). In interpreting the circular record two factors, time and wind direction, must be read, and wind speed estimated.

(a) The time factor (Fig. 5A and C). Since the gauge's turn-table makes one revolution every 26 hours its circumference must be divided into 26 equal parts, i.e. chronological calibration. The two hours in excess of a day's duration in the Casella thermo-hydrograph clock are marked in Figure 5A by the "overlap" sector. The gauge was normally changed between 0900–1000 every day, thus, the

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times shown in the margin of Figure 5C start at 0900.

(b) Wind direction (Fig. 5A). As previously described (Giglioli, 1964) the axes of the turn-table and the stylus circle (Fig. 5A, 1) are parallel and the radius of the stylus circle is less than ½ the radius of the turn-table; therefore, the circles drawn by the stylus follow a concentric path through the medians of the radii of the turn-table (Fig. 5A). Also, when the gauge is properly orientated, the NS diameter of the stylus circle is aligned along the radius of the turn-table with N at its margin.

Thus, any arc is made by the stylus at the time when the N. point of the same circle is opposed to the time calibrated on the turn-table margin (Fig. 4; direction, md. at time, tm.).

Arcs whose median corresponds to the cardinal and subcardinal points at different times of the day are shown in Figure 5A.

THE OVERLAY. In order to interpret wind direction and the time of its occurrence from the record, two overlays are needed (Fig. 2).

(a) Time overlay (Fig. 2 Ov.). A large Perspex sheet with a circle which corresponds exactly to the diameter of the turn-table drawn on it. The circumference of the circle is divided radially into 26 equal segments marked with the hours of the day, where each hourly radius intersects the circumference a fine hole is drilled through the perspex, similarly the 0900–1000 hrs. or starting segment is marked by 4 holes at 15 minute intervals.

(b) Wind direction (Fig. 2, co.). A Perspex circle of exactly the same size as the stylus circle is etched with the cardinal, sub-cardinal and tertiary points of the compass. To it is fixed a shank or tail which allows it to revolve at the same distance from the centre of the turn-table as the stylus circle.

The compass overlay (Fig. 2, co.) is drilled centrally and a small countersunk screw (p^1) forms the pivot of its paired radial callipers (cl.) and direction indicator (i).

Another pivot screw (p^2) with one pointed end centres the shank of the compass overlay on the time overlay so that the former can revolve radially on the latter. The pointed end of the pivot projects below the time overlay (Fig. 3, p^2) and rests in the median hole (Fig. 3, cb.) in the plywood base-board (bs.).

READING THE TRACE. Once the record is removed from the turn-table it is carefully folded in four to find its centre, a hole is then made at the centre with a cork borer (Fig. 3). The record is threaded on to the central pivot (p^2) of the overlay, which is then pushed into the centre hole of the baseboard so that the record is now sandwiched and flattened between the time overlay and baseboard. The marginal note showing the time and point at which the record started are found and the overlay moved until the correct time is opposed to the starting point. Since 15-minute holes are drilled in the first hour of the overlay, a pin (Fig. 4 pn.) can be pushed down through it and the record into the baseboard so that these are locked.

Holding the tail or shank of the compass overlay (Fig. 4) the arcs on the record are read anti-clockwise by matching the periphery of the compass overlay to each arc. This indicates the variation in wind direction at that time. The callipers are opened or closed to the extremities of the arc and then the indicator (i) is moved to bisect this arc. The indicator reading then shows the mean wind direction (Fig. 4, md.). The time of the observation is supplied for this and any other reading by looking at the time on the marginal scale which is opposed to the North point of the compass overlay.

The force of the wind is estimated by comparing the density of the trace with the initial calibration made with a flow meter. (The greater the combined density and width of the arcs, the stronger the wind.)

The example illustrated in Figure 4 shows a Force III breeze varying from NNW x NW to WSW x W with mean

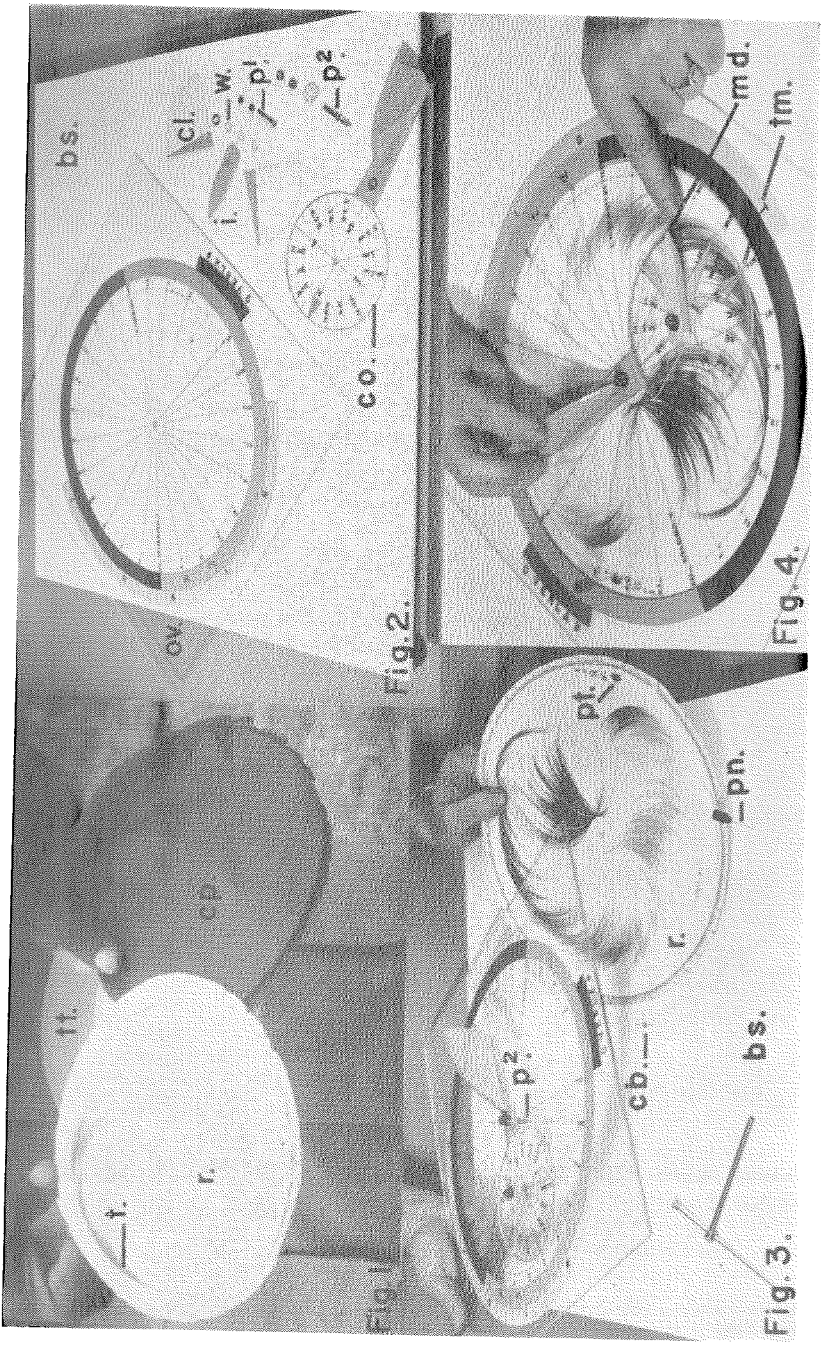
Fig. 1
tt.
t.
r.
cp.
ov.
Fig. 2.
bs.
cl.
w.
i.
p1.
p2.
co.
Fig. 3.
p2.
cb.
bs.
r.
pn.
pt.
Fig. 4.
md.
tm.

KEY TO ABBREVIATIONS

bs. baseboard.
cb. centre hole of baseboard.
cl. callipers for measuring width of oscillation.
co. compass overlay of same radius and position as circle inscribed by the stylus of the wind vane.
cp. carbon paper.
i. indicator of median wind direction.
md. mean direction of wind occurring at time (tm.) i.e. 1855 hours.
ov. overlay with time marked radially.
p 1. pivot of indicator and callipers.
p 2. pointed pivot joining overlays and centering them to record and baseboard.
pn. stop pin.
pt. place and time record started.
r. record.
t. trace of stylus.
tm. time of wind with mean direction (md.) i.e. 1855 hours.
tt. turn-table.
w. washers.
1. circular path of stylus.
2. path of the centre of the stylus circle along the mid-radii of the turn-table.

FIG. 1.—The turn-table, carbon overlay and graphed record on removal from the wind gauge. FIG. 2.—The component parts of the overlays, used for reading the 24-hour record of wind, displayed on the baseboard. The large overlay (ov.) gives the time of observation while the smaller compass overlay (co.) rotates radially on the larger one and is of the same size and disposition as one revolution of the stylus of the wind vane. FIG. 3.—The assembled overlays being centred on the wind record and base-board. A hole is made with a cork borer at the centre of the overlay, which is then threaded on to the pointed pivot (p 2) at the centre of the time overlay before placing this pivot in the median hole (cb.) of the base-board. FIG. 4.—The record to be read is matched to the time scale on the margin of the time overlay and zeroed by pushing the stop pin (pn.) through overlay and record into the baseboard. By moving the compass overlay counter-clockwise the mean direction of wind movement is read. Time is indicated by the N point on the compass overlay on the marginal time scale on the lower overlay. The indicator points to a mean direction WNW (md.) at 1855 hours (tm.).

FIG. 5.—A. shows a compass circle as inscribed by the stylus and its path in relation to the turn-table. Also shown are the position of arcs produced by winds from the cardinal and subcardinal points of the compass at different times of the day. B-E. Actual 24 hour wind records showing the type of trace the instrument produces and the variation in width, frequency and disposition of oscillation, depending on wind speed and direction. Single line trace indicates a wind under Force I, Beaufort scale. The dotted arcs in the traces are not due to the stylus (Figs. 3 and 4) but to retouching. (See page 386 for Fig. 5)

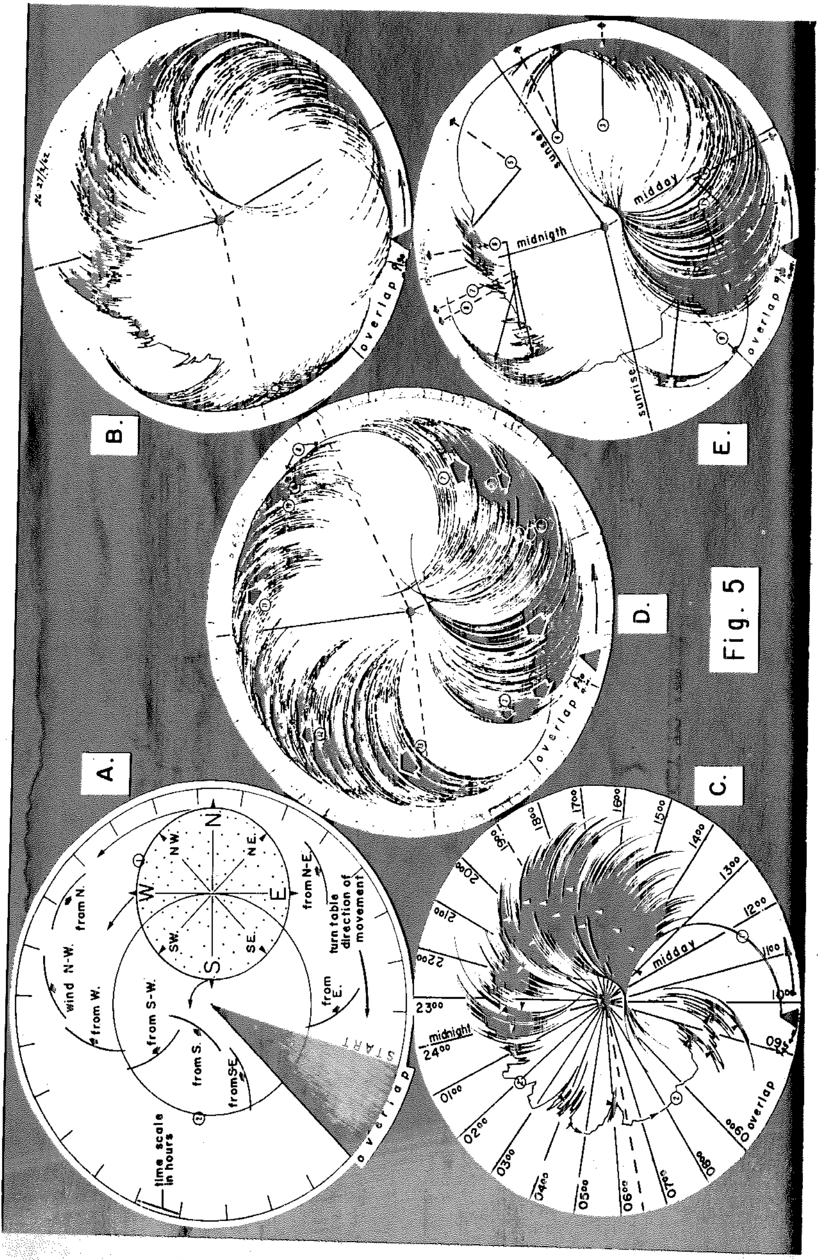
A.
B.
C.
D.
E.
N
S
E
W
NW.
NE.
SW.
SE.
wind N-W.
from N.
from W.
from S-W.
from S.
from S-E.
from E.
from N-E.
turn table direction of movement
time scale in hours
START
overlap
midnight
midday
sunset
sunrise
midnigth
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200

Fig. 5

direction from WNW (md.) at 1855 (tm.) in the evening.

EXAMPLES AND RESULTS. Figure 5 shows four daily records obtained with this apparatus.

(a) Figure 5B. This record was started at 0930 on the 26th and removed at 0900 on the 27/2/1962, results are given as follows in degrees.

0930 to 1030 Force III from 325°; to 1245, III from 315°; to 1430, III from 297°; to 1530, III from 247°; to 1630, II-III from 315°; to 1800, IV from 270°; to 2000, III from 282°; to 2045, I-II from 270°; to 2130, I-II from 257°; to 2200, I-II from 270°; to 2230, I-II from 282°; to 2330, I-II from 292°; to 2400, I-II from 282°; to 0245, 2¾ hours of drift under Force I with puffs from 275°; to 0430, III from 327°; to 0615, II from 337°; to 0800, II from 360° and to 0900, Force II from 12°.

(b) Figure 5C. Note the marginal starting point at 0945 and single trace (1) produced when after marking the start with the vane aligned N-S it was then released to begin recording a S.W. breeze. The variation of mean wind direction in the course of the day is shown by arrowheads. From 2100 to 0830 only a few irregular puffs stronger than Beaufort I occur, thus the continuous single line recording (2).

(c) Figure 5D. The direction of air movement at selected times in a relatively windy day are shown by the arrowheads—1, ENE x E; 2, ENE x NE; 3, E; 4, NE; 5, ENE; 6, ENE x NE; 7, ENE; 8, 1 hour of calm or drift under Force I; 9, N x NNE; 10, NE; 11, ENE; 12, ENE; 13, ENE x E. 1–7 Force VI; 9–10 Force IV; 11–12 Force V-VI; 13 Force VI.

(d) Figure 5E. A day of variable wind and calm night; nine selected readings are shown, the solid line in each observation marks the mean wind direction while the radial broken line indicates the time of observation. 1, ENE x E at 1030 on the 15/2/1962; 2, ENE at 1145; 3, N at 1625; 4, NNE at 1830; 5, WNW x W at 2037; 6, Westerly puffs at 2335; 7, WNW x W at 2440; 8, NW at 2455; 9, ENE x E at 0900 on the 16/2/1962.

TECHNICAL NOTE. The compass overlay used was calibrated with the cardinal, secondary and tertiary points of the compass. A more useful measurement would be its division into 360°; to this purpose, once having obtained a circular protractor of suitable diameter, the apparatus could be built in scale with it.

It will be noted that since the southerly winds are recorded around the centre of the turn-table, they may produce an obscured tracing if this wind prevails in the locality under observation; this can be overcome either by using a larger turntable or by changing the relation of the rotating arm to the wind vane, possibly reversing it so that S is registered marginally on the turn-table. However, whatever is done it must be remembered to orient the compass overlay in a similar manner.

The use of printed graphs with concentric circles of suitable radii representing the points of the compass, and radial lines, the hourly divisions, would reduce the time taken and eliminate the initial difficulties met in interpreting the record, but some device for centering the printed record on the turn-table would be required and an improved clip for holding the record and carbon overlay devised.

ACKNOWLEDGMENTS. I wish to thank Dr. I. McGregor, O.B.E., Medical Research Council Laboratories, Gambia, for permission to publish and Professor D. S. Bertram and the London School of Hygiene and Tropical Medicine for their hospitality.

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See page 385 for legend for Fig. 5.)