have tabulated, these storms appear to be about half as frequent only at the beginning as at the end of the south-west monsoon.

It is probable that in the course of a few years, if not already, the observations of currents and sea temperatures, collected by the Meteorological Department of the Board of Trade, will afford data for a satisfactory discussion of this subject, which is one of great importance to the comprehension of the meteorology of the Bay.

Postscript. Received June 29, 1869*.

Since the above was written, I have visited Chittagong, and have found that the elevation of the barometer-cistern at that place above sea-level (which had been reported as 166·46 feet) is actually about 108 ft. only. This correction requires an alteration of the reduced barometric pressures for Chittagong (given on p. 473), which will consequently stand as follows:—

	23rd.	24th.	25th.	26th.	27th.
Chittagong ..	29·906	29·913	29·949	29·873	29·894

A few corrections must also be made in the text. The excess of pressure at Chittagong, as compared with certain other stations on the 23rd and 25th, disappears, and on the 26th and 27th the noon pressure at this place becomes lower than at any other station. The conclusions arrived at in the foregoing paper are, however, unaffected by the correction.

III. "Note upon a Self-registering Thermometer adapted to Deep-sea Soundings." By W. A. Miller, M.D., Treas. and V.P.R.S. Received June 3, 1869.

The Fellows of the Royal Society are already aware that the Admiralty, at the request of the Council of the Society, have placed a surveying-vessel at the disposal of Dr. Carpenter and his coadjutors for some weeks during the present summer, to enable them to institute certain scientific inquiries in the North Sea. Among the objects which the expedition has in view is the determination of deep-sea temperatures.

Now it is well known that self-registering thermometers of the ordinary construction are liable to error when sunk to considerable depths in water, in consequence of the diminution produced for the time in the capacity of the bulb under the increased pressure to which it is subjected. The index, from this cause, is carried forward beyond the point due to the effect of mere temperature, and the records furnished by the instrument rise too high†.

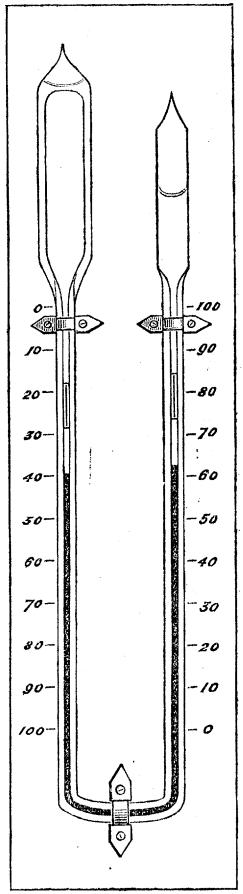
A simple expedient occurred to me as being likely to remove the diffi-

* A chart, with wind arrows, showing the limits of the cyclone, accompanies the paper, and is preserved for reference in the Archives of the Society.

† In sea-water of sp. gr. 1·027, the pressure in descending increases at the rate of 280 lbs. upon the square inch for every 100 fathoms, or exactly one ton for every 800 fathoms.

culty; and as upon trial it was found to be perfectly successful, I have thought that a notice of the plan pursued might not be unacceptable to future observers.

The form of self-registering thermometer which it was decided to employ is one constructed upon Six's plan. Much care is requisite in adjusting the strength of index-spring, and the size of the pin, so as to allow it to move with sufficient freedom when pressed by the mercury, without running any risk of displacement in the ordinary use of the instrument while raising or lowering it into the water. Several of these thermometers have been prepared for the purpose with unusual care by Mr. Casella, who has determined the conditions of strength in the spring and diameter of tube most favourable to accuracy. He has also himself had an hydraulic press constructed expressly with the view of testing these instruments. By means of this press the experiments hereafter to be described were made.



The expedient adopted for protecting the thermometers from the effects of pressure consisted simply in enclosing the bulb of such a Six's thermometer in a second or outer glass tube, which was fused upon the stem of the instrument in the manner shown in the accompanying figure. This outer tube was nearly filled with alcohol, leaving a little space to allow of variation in bulk due to expansion. The spirit was heated to displace part of the air by means of its vapour, and the outer tube and its contents were sealed hermetically.

In this way, variations in external pressure are prevented from affecting the bulb of the thermometer within, whilst changes of temperature in the surrounding medium are speedily transmitted through the thin stratum of interposed alcohol. The thermometer is protected from external injury by enclosing it in a suitably constructed copper case, open at top and bottom, for the free passage of the water.

In order to test the efficacy of this plan, the instruments to be tried were enclosed in a strong wrought-iron cylinder filled with water, and submitted to hydraulic pressure, which could be raised gradually till it reached three tons upon the square inch, and the amount of pressure could be read as the experiment proceeded upon a gauge attached to the apparatus.

Some preliminary trials made upon the 5th of May showed that the

press would work satisfactorily, and that the form of thermometer proposed would answer the purpose.

These preliminary trials showed that, even in the thermometers with protected bulbs, a forward movement of the index of from 0°·5 to 1° F. occurred during each experiment. This, however, I believed was caused, not by any compression of the bulb, but by a real rise of temperature, due to the heat developed by the compression of the water in the cavity of the press.

This surmise was shown to be correct by some additional experiments made last week to determine the point. On this occasion the following thermometers were employed:—

No. 9645. A mercurial maximum thermometer, on Prof. Phillips's plan, enclosed in a strong outer tube containing a little spirit of wine, and hermetically sealed.

No. 2. A Six's thermometer, with the bulb *protected*, as proposed by myself, with an outer tube.

No. 5. A Six's thermometer, with a long recurved cylindrical bulb, also *protected* in a similar manner.

No. 1. Six's thermometer, with cylindrical bulb of extra thickness, *not protected.*

No. 3. Six's thermometer, with spherical bulb, extra thick glass, *not protected.*

No. 6. Admiralty instrument, Six's thermometer, ebonite scale, bulb *not protected.*

No. 9651. An ordinary Phillips's maximum mercurial thermometer, spherical bulb, *not protected.*

The hydraulic press was exposed in an open yard, and had been filled with water several hours before. A maximum thermometer, introduced into a wrought-iron tube filled with water, open at one end to the outer air, closed at the other, where it passed into the water contained in the press, registered 46°·7 at the commencement, and 47° at the end of the experiment. Temperature of the external air 49° F.

In commencing the experiment, the seven thermometers under trial were introduced into the water in the cavity of the press, and after a lapse of ten minutes the indices of each were set, carefully read, and each instrument was immediately replaced in the press, which was then closed, and by working the pump the pressure was gradually raised to $2\frac{1}{2}$ tons upon the inch. It was maintained at this point for forty minutes, in order to allow time for the slight elevation of temperature caused by the compression of the water to equalize itself with that of the body of the apparatus. At the end of the forty minutes the pressure was rapidly relaxed. A corresponding depression of temperature was thus occasioned, the press was opened immediately, and the position of the indices of each thermometer was again read carefully; and the water was found to be at a temperature sensibly lower than before the experiment began, by about 0°·6 F. By this means it was proved that the forward movement of the index in the protected thermometers, amounting to 0°·9, was really due to temperature,

and not to any temporary change in the capacity of the bulb produced by pressure.

This will be rendered evident by an examination of the subjoined Table of observed temperatures:—

First Series: Pressure $2\frac{1}{2}$ tons per square inch.

Number of Thermometer.	Minimum index.		Maximum index.		Maximum mercury.
	Before.	After.	Before.	After.	After.
Protected ... 9645	.....	.....	47·0	47·7	
„ ... 2	47·0	46·5	46·7	47·6	46·5
„ ... 5	47·0	46·3	46·5	47·6	46·0
Mean	.....	.....	.....	47·6	
Unprotected. 1	46·7	46·4	46·5	54·0	46
„ 3	47·0	46·5	46·5	56·5	46
„ 56	47·0	46·0	47·0	55·5	46
„ 9651	.....	.....	46·7	118·5	
Mean	46·9	46·3	46·7	.....	46·1
Temperature of external air.....			49	49	
Temperature of thermometer in press			46·7	47	

In the Phillips's maximum thermometer, with unprotected spherical bulb, No. 9651, the bulb had experienced so great a degree of compression as to drive the index almost to the top of the tube. In all the other unprotected instruments, which had been made with bulbs of unusual thickness, the index had been driven beyond its proper position from 6°·4 to 8°·9 F.; and it is obvious that the amount of this error must vary in each instrument with the varying thickness of the bulb and its power of resisting compression.

Notwithstanding the great pressure to which these instruments had been subjected, all of them, without exception, recovered their original scale-readings as soon as the pressure was removed.

It will be seen that the mean rise of temperature indicated by the three protected instruments was 0°·9 F., whilst the mean depression registered on removing the pressure amounted upon all the instruments which admitted of its measurement to 0°·6, an agreement as close as was to be expected from the conditions of the experiment.

A second set of experiments was made upon the same set of instruments, with the exception of 9651; but the pressure was now raised to 3 tons upon the inch; this was maintained for ten minutes. When it had risen to $2\frac{3}{4}$ tons a slight report was heard in the press, indicating the fracture of one of the thermometers. On examining the contents of the press afterwards it was found that No. 2 was broken, the others were uninjured.

The broken thermometer was the earliest constructed upon the plan now proposed, and it was consequently not quite so well finished as subsequent practice has secured for those of later construction. The results of the trial under the higher pressures showed an increase in the amount of compression experienced by the unprotected instruments rising in one instance to as much as 11°·5 F. With the protected instruments the rise did not exceed 1°·5, due, as before, to the heat evolved from the water by its compression.

A pressure of 3 tons, it may be observed, would be equal to that of 448 atmospheres of 15 lb. upon the square inch; and if it be assumed that the diminution in bulk of water under compression continues uniformly at the rate of 47 millionths of its bulk for each additional atmosphere, the reduction in bulk of water under a pressure of 3 tons upon the square inch will amount to about $\frac{1}{47}$ of its original volume. This probably is too high an estimate, as the rate of diminution would most likely decrease as the pressure increases.

IV. "Magnetic Survey of the West of France." By the Rev. Stephen J. Perry, F.R.A.S., F.M.S. Communicated by the President. Received June 3, 1869.

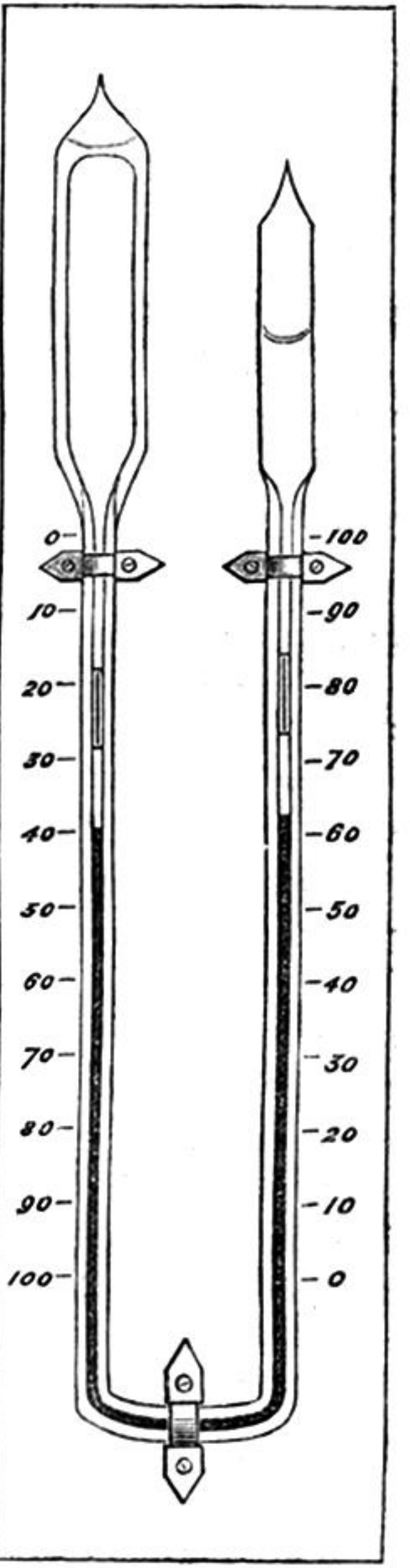
(Abstract.)

This survey was undertaken by the Rev. W. Sidgreaves and myself in connexion with the Observatory at Stonyhurst College. The instruments employed were those in constant use for the monthly observations of the magnetic elements at this observatory, *i. e.* Barrow's dip-circle, No. 33, a unifilar by Jones, and Frodsham's chronometer, No. 3148. A portable altazimuth and an aneroid barometer were kindly placed at our disposal by the late Mr. Cooke.

A complete set of observations of the dip, declination, and horizontal intensity were taken at the following stations:—Paris, Laval, Brest, Vannes, Angers, Poitiers, Bordeaux, Abbadia (near Hendaye), Loyola, Bayonne, Pau, Toulouse, Périgueux, Bourges, Paris (a second time), and Amiens. The chronometer was compared on every possible occasion, and its rate was found to be nearly always 2^s per day.

The dip was observed according to the description of the observation given by the President of the Royal Society in the 'Manual of Scientific Inquiry.'

The method of vibrations and deflections was invariably adopted for determining the horizontal component of the intensity. For the declination it was deemed most convenient to find the azimuth of a fixed mark by observing transits of the sun with Cooke's altazimuth, and then to measure the azimuthal angle between the magnet and the fixed mark with Jones's unifilar. Dr. Lloyd's method, by reflection, was made use of only at Brest. The results of these observations, reduced to the epoch January 1st, 1869, are contained in the following Table:—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