XXIII. *Observations and Experiments on the daily variation of the Horizontal and Dipping Needles under a reduced directive power. By* PETER BARLOW, *Esq. F. R. S. of the Royal Military Academy. Communicated by* DAVIES GILBERT, *Esq. V. P. R. S.*

Read June 12, 1823.

IT is now just a century since Mr. GRAHAM discovered the daily change in the variation of the horizontal needle, subsequent to which time numerous observations have been made on the same subject by WARGENTIN, CANTON, GILPIN, Colonel BEAUFOY and others, which have all confirmed, with certain shades of variety, the general fact as first described by the ingenious philosopher above named.

The actual daily change however is so small, even in the horizontal needle, that it can only be detected with the most careful observations and with the most delicate instruments; and in the dipping needle that change, if any, is so extremely minute, as hitherto to have escaped observation: for it was only in the year 1820, that the Royal Academy of Sciences of Copenhagen proposed the determination of this motion, on satisfactory experiments, as the prize subject for that year; but the prize, I understand, has never been adjudged, no satisfactory communication having been received.

Under this difficulty of observation it occurred to me, that it would be possible to increase this deviation on both needles, so as to render it distinctly observable, by reducing the directive power of the needle by means of one or two magnets,

properly disposed to mask, at least in part, the terrestrial influence; a method which has been long practised by mineralogists and others, when the object has been to detect minute attractions. I expected by this means that the cause, whatever it might be, that produces the daily variation, would exhibit itself in an encreased degree, and thereby render the results more perspicuous, and fix with more precision than has hitherto been done, the time of change and moment of maximum effect.

Suppose, for example, that a finely suspended horizontal needle, under the natural influence of the earth, makes one vibration in 2″, and that by masking the terrestrial influence by magnets properly adjusted, that time of vibration is encreased to 8″; then it would follow that the directive power was reduced to one sixteenth of the former, and consequently, that any lateral magnetic force acting upon the needle would produce an effect sixteen times greater than before; so that if the former were 12′, the new effect or deviation might be expected to amount to between three and four degrees, and therefore be such as to admit of distinct and satisfactory observation.

A course of experiments carried on for a few days, convinced me that my ideas were correct, and that we might, while the needle was kept in its natural meridian, or rather adjusted to that direction, produce a daily variation to almost any amount. I obtained, for instance, the first day, a maximum deviation of 3° 40′; the second, I encreased it by bringing up my magnets to 7°; the third day I reduced it to 2°, and so on. I found, also, that a very considerable daily change would exhibit itself with the north end held to the south, to

the east, west, and, in short, in any position at pleasure, at least within certain limits, which will be pointed out as we proceed.

For this it is only necessary, first, to deflect the needle by repulsion into any required position, and then, by means of another magnet, to modify its directive power, in the same way as when in its natural meridian. Or the same may be done by bringing two magnets with their contrary poles pointing inwards, and each opposite to the pole of the same name of the needle placed between them, and by a slight adjustment of the former to produce the deviation in question: or, which is perhaps still better, the opposing magnets may be brought into the actual direction of the dip, and then adjusted to produce the deflection required.

Having mentioned my ideas and first experiments to my colleague, Mr. CHRISTIE, and having expressed a wish that he would repeat them for the sake of verification, he very readily agreed to undertake a complete set, with the needle in its natural meridian, by means of a very delicate compass, and an apparatus he had employed for other experiments, and which admitted of his bringing his neutralizing magnets very exactly into the line of the dip. In the mean time I proposed to undertake the observations on the dipping needle, and on the horizontal needle in different directions; viz. with its north end pointing to the south, east, west, &c. Having, however, met with some embarrassment in the commencement, and having employed, in consequence, a longer time in the observations than I had anticipated, Mr. CHRISTIE, after having finished his observation in the meridian, continued them at other points, and has thereby detected several curi-

ous and minute peculiarities, which, with his other experiments, will, I hope, accompany this Memoir.

Account of the observations made on the daily variation of the horizontal needle in various directions.

My first experiments, as I have already stated, were only matters of trial, from which I had merely ascertained that the idea I had formed was practicable, and that in certain situations the needle had certain directions of motion, but I had obtained no numerical results. Having, however, provided myself with a needle proper for the purpose, very delicate and light, and eight inches and a half in length, I began, towards the end of March, to register the amount of the daily change at every hour, or half hour, from morning to night; my son taking the observations during my occasional absence.

My first observation in the new series was made with the north end of the needle pointing to the west, balanced in that position with two magnets placed to the southward attracting each extremity; the directive power was considerably reduced, and I obtained a maximum deviation of $3^\circ\ 15'$; which happened at about eleven o'clock in the forenoon, and from which time the variation decreased to a late hour in the evening. The needle was kept in this position for three days, with some change of directive power, but the character of the results, as to the direction of motion, the times of commencement and maximum, &c. were of precisely the same nature, but the amount was more or less, according to the directive power left upon the needle.

Having, however, after a few days removed my apparatus

from the room in which the experiments had hitherto been made, into a bower in my garden, and having detected a remarkable difference in the results obtained in these two situations, I determined to commence the experiments *de novo* in this latter spot, which was at least thirty yards distant from any building; and afterwards to examine the cause of the difference in question. This examination is reported in the conclusion of this article.

All the following experiments, therefore, will be understood to have been made in the open air, proper precautions having been taken to ensure stability. The results are arranged according to the direction in which the needle pointed; and the character of the daily deviation is distinguished as follows. The reader must conceive himself as facing the north end of the needle; then, when that end passes to his right hand the deviation is marked (+), and when to his left hand (—); the bearing at six o'oclock in the morning being marked zero.

TABLE *of observed daily Variations.*

North end of Needle to North.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	° ′
6 0	0 0	0 0	0 0
7 0	−0 10	+0 5	−0 5
8 0	+0 10	+0 15	+0 20
9 0	+0 30	+0 50	+1 0
10 0	—	+1 0	—
10 30	+1 5	+1 0	+1 50
11 0	+1 45	+1 30	+2 10
11 30	+2 5	+1 45	+2 20
12 0	+2 5	+1 45	+3 0
1 0	+2 50	+1 50	+3 10
2 0	+2 40	+1 30	+2 45
3 0	+2 30	+1 30	+2 45
4 0	+2 0	+1 30	—
5 0	+1 30	+1 0	+1 40
6 0	+1 30	—	—
7 0	+1 10	—	+1 0
8 0	+1 0	—	+0 45
9 0	+1 0	—	+0 30
10 0	+0 45	+0 15	+0 30
11 0	+0 10	—	—

North end to the South.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	0 0	0 0	
7 0	−0 30	−0 15	
8 0	−0 40	−0 45	
9 0	−0 55	−1 5	
10 0	—	−1 25	
10 30	−1 10	−1 50	
11 0	−1 10	−1 50	
11 30	−1 10	−2 0	
12 0	—	—	
1 0	−1 15	−2 20	
2 0	−1 5	−2 20	
3 0	−1 0	−2 20	
4 0	—	−1 30	
5 0	—	−1 10	
6 0	−0 45	−1 10	
7 0	−0 35	—	
8 0	—	−0 45	
9 0	−0 15	−0 30	
10 0	—	−0 30	
11 0	—	—	

No observation on the 3rd day.

North end to N. N. E.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	0 0	0 0	
7 0	−0 5	0 0	
8 0	+0 15	+0 20	
9 0	+0 40	+0 45	
10 0	+1 0	—	
10 30	+1 5	—	
11 0	+1 40	+1 45	
11 30	+1 40	+2 0	
12 0	+2 0	—	
1 0	+2 10	—	
2 0	+2 10	+2 0	
3 0	—	+1 50	
4 0	—	—	
5 0	+1 30	+1 45	
6 0	+1 35	—	
7 0	—	+0 55	
8 0	+1 10	+0 55	
9 0	+0 50	+0 45	
10 0	+0 30	+0 0	
11 0	−0 0	−0 10	

North end to S. S. W.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	0 0	0 0	
7 0	−0 10	−0 20	
8 0	−0 30	−0 40	
9 0	−0 45	−1 0	
10 0	−1 0	−1 20	
10 30	−1 10	—	
11 0	−1 30	—	
11 30	−1 30	−2 0	
12 0	−1 30	−2 20	
1 0	−2 0	−2 30	
2 0	−2 0	—	
3 0	—	—	
4 0	—	−1 30	
5 0	—	—	
6 0	−1 10	−1 15	
7 0	−1 0	−0 55	
8 0	−1 0	−0 50	
9 0	−1 0	—	
10 0	−0 30	−0 40	
11 0	—	—	

No observation on the 3d day.

North end N. E.				South end S. W.			
Hours.	1st Day.	2nd Day.	3rd Day.	Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′		h. m.	° ′	° ′	
6 0	0 0	0 0		6 0	0 0	0 0	
7 0	+ 0 10	+ 0 15		7 0	— 0 20	0 0	
8 0	+ 0 30	+ 0 15		8 0	— 0 35	— 0 20	
9 0	+ 0 45	+ 0 50		9 0	— 0 45	— 0 30	
10 0	+ 1 0	—		10 0	— 0 45	— 0 40	
10 30	+ 1 20	—		10 30	— 1 10	—	
11 0	+ 1 50	+ 1 30		11 0	— 1 10	—	
11 30	+ 1 50	—		11 30	— 1 10	— 1 30	
12 0	+ 2 0	+ 2 10		12 0	— 1 50	— 1 30	
1 0	+ 2 0	—		1 0	— 1 50	— 1 30	
2 0	+ 1 45	+ 1 15		2 0	— 1 40	— 1 15	
3 0	—	+ 1 15		3 0	—	—	
4 0	—	+ 1 15		4 0	—	— 1 0	
5 0	—	+ 1 0		5 0	—	— 1 0	
6 0	+ 0 45	+ 0 45		6 0	— 0 45	— 0 50	
7 0	+ 0 45	—		7 0	— 0 30	—	
8 0	+ 0 30	+ 0 25		8 0	— 0 30	—	
9 0	+ 0 10	+ 0 25		9 0	— 0 0	—	
10 0	— 0 5	0 0		10 0	+ 0 5	—	
11 0	— 0 5	—		11 0	+ 0 5	+ 0 10	

No observation on the 3rd day.

No observation on the 3rd day.

North end E. N. E.				North end W. S. W.			
Hours.	1st Day.	2nd Day.	3rd Day.	Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′		h. m.	° ′	° ′	
6 0	0 0	0 0		6 0	— 0 0	0 0	
7 0	+ 0 10	+ 0 40		7 0	— 0 30	— 0 40	
8 0	+ 0 45	+ 0 55		8 0	— 1 0	—	
9 0	+ 1 15	+ 1 30		9 0	— 1 0	—	
10 0	+ 2 0	+ 2 10		10 0	— 1 45	— 2 0	
10 30	+ 2 10	+ 2 40		10 30	— 2 25	— 2 30	
11 0	—	—		11 0	— 2 50	— 2 45	
11 30	—	—		11 30	— 2 50	—	
12 0	—	—		12 0	— 2 50	—	
1 0	+ 2 0	+ 2 30		1 0	— 2 10	2 10	
2 0	+ 2 0	+ 2 10		2 0	—	—	
3 0	—	—		3 0	—	2 15	
4 0	—	+ 1 40		4 0	—	—	
5 0	—	+ 1 0		5 0	— 1 30	2 0	
6 0	—	—		6 0	—	—	
7 0	+ 1 10	—		7 0	—	—	
8 0	+ 0 40	+ 0 50		8 0	— 1 0	1 30	
9 0	+ 0 20	+ 0 20		8 0	— 1 0	1 15	
10 0	0 0	— 0 5		10 0	— 0 25	0 50	
11 0	— 0 15	—		11 0	+ 0 5	— 0 20	

No observation on the 3rd day.

No observation on the 3rd day.

North end East.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	0 0	0 0	
7 0	+ 1 30	+ 0 30	
8 0	+ 1 50	+ 1 0	
9 0	+ 2 0	+ 1 15	
10 0	+ 3 15	+ 1 35	
10 30	—	+ 2 0	
11 0	+ 3 15	+ 2 0	
11 30	—	+ 2 0	
12 0	+ 3 15	+ 2 0	
1 0	+ 3 10	—	
2 0	+ 2 30	+ 1 30	
3 0	+ 1 30	+ 1 30	
4 0	+ 1 20	+ 1 10	
5 0	+ 0 45	+ 1 0	
6 0	+ 0 45	+ 1 0	
7 0	+ 0 10	+ 1 10	
8 0	+ 0 5	+ 0 50	
9 0	+ 0 0	+ 0 30	
10 0	— 0 5	+ 0 5	
11 0	—	—	

No observation on the 3rd day.

North end West.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	° ′
6 0	0 0	0 0	0 0
7 0	— 0 15	— 0 0	— 0 10
8 0	— 1 5	— 0 5	— 1 0
9 0	— 1 35	— 0 35	— 1 20
10 0	— 2 30	— 0 50	— 2 15
10 30	— 2 55	— 1 25	—
11 0	— 3 5	— 1 40	— 2 45
11 30	— 3 5	— 1 40	— 2 45
12 0	— 2 25	— 1 20	— 2 0
1 0	—	— 1 0	—
2 0	— 2 30	— 0 40	— 2 0
3 0	— 2 20	— 0 35	— 2 0
4 0	— 2 10	— 0 30	— 1 45
5 0	— 2 10	— 0 25	— 1 0
6 0	— 2 0	— 0 20	—
7 0	— 1 55	— 0 10	— 0 30
8 0	— 1 35	+ 0 5	— 0 30
9 0	—	+ 0 20	—
10 0	— 0 55	+ 0 25	—
11 0	—	—	—

North end E. S. E,			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	° ′
6 0	—	0 0	0 0
7 0	0 0	+ 0 5	+ 0 10
8 0	+ 0 10	+ 0 15	+ 0 30
9 0	+ 0 20	+ 0 30	—
10 0	+ 0 35	+ 0 35	—
10 30	—	+ 0 45	—
11 0	+ 0 40	—	—
11 30	+ 0 40	+ 0 55	+ 1 0
12 0	+ 0 40	—	+ 0 55
1 0	+ 0 35	+ 0 50	+ 0 40
2 0	+ 0 35	+ 0 55	—
3 0	+ 0 35	+ 0 45	—
4 0	+ 0 35	+ 0 45	—
5 0	+ 0 30	—	—
6 0	+ 0 25	+ 0 30	—
7 0	+ 0 15	+ 0 30	+ 0 20
8 0	+ 0 5	+ 0 10	+ 0 10
9 0	— 0 5	+ 0 5	+ 0 0
10 0	0 5	+ 0 0	— 0 5
11 0	—	—	— 0 5

North end W. N. W.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	—	0 0	
7 0	0 0	0 0	
8 0	— 0 20	— 0 15	
9 0	— 0 40	—	
10 0	— 0 50	— 0 20	
10 30	—	—	
11 0	—	—	
11 30	—	—	
12 0	— 0 55	— 0 22	
1 0	— 0 55	— 0 30	
2 0	— 0 50	— 0 30	
3 0	— 0 50	—	
4 0	—	— 0 20	
5 0	—	—	
6 0	—	—	
7 0	— 0 30	0 0	
8 0	— 0 20	—	
9 0	— 0 5	+ 0 10	
10 0	+ 0 5	+ 0 15	
11 0	—	—	

No observation on the 3rd day.

North end S.E.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	0 0	0 0	
7 0	+ 0 10	0 0	
8 0	+ 0 20	+ 0 25	
9 0	+ 0 35	+ 0 25	
10 0	+ 0 45	+ 0 40	
10 30	+ 1 0	+ 1 10	
11 0	+ 1 5	+ 1 10	
11 30	+ 1 5	—	
12 0	—	—	
1 0	+ 1 10	—	
2 0	—	+ 1 0	
3 0	—	+ 1 0	
4 0	—	—	
5 0	+ 0 40	+ 0 55	
6 0	+ 0 40	+ 0 45	
7 0	—	—	
8 0	—	—	
9 0	+ 0 20	+ 0 15	
10 0	+ 0 10	—	
11 0	—	+ 0 5	

No observation on the 3rd day.

North end N. W.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	0 0	0 0	
7 0	— 0 10	— 0 5	
8 0	— 0 15	— 0 20	
9 0	— 0 30	— 0 30	
10 0	— 0 45	—	
10 30	— 0 50	— 1 10	
11 0	— 0 55	— 1 0	
11 30	—	— 1 0	
12 0	— 0 55	—	
1 0	— 0 50	—	
2 0	— 0 50	— 0 45	
3 0	— 0 50	—	
4 0	—	— 0 45	
5 0	— 0 50	—	
6 0	—	— 0 40	
7 0	— 0 45	—	
8 0	— 0 30	— 0 30	
9 0	—	—	
10 0	— 0 5	— 0 15	
11 0	— 0 5	—	

No observation on the 3rd day.

North end S.S.E.½ South.*			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.			
6 0			
7 0			
8 0			
9 0			
10 0			
10 30			
11 0			
11 30			
12 0			
1 0			
2 0			
3 0			
4 0			
5 0			
6 0			
7 0			
8 0			
9 0			
10 0			
11 0			

Very little daily variation.

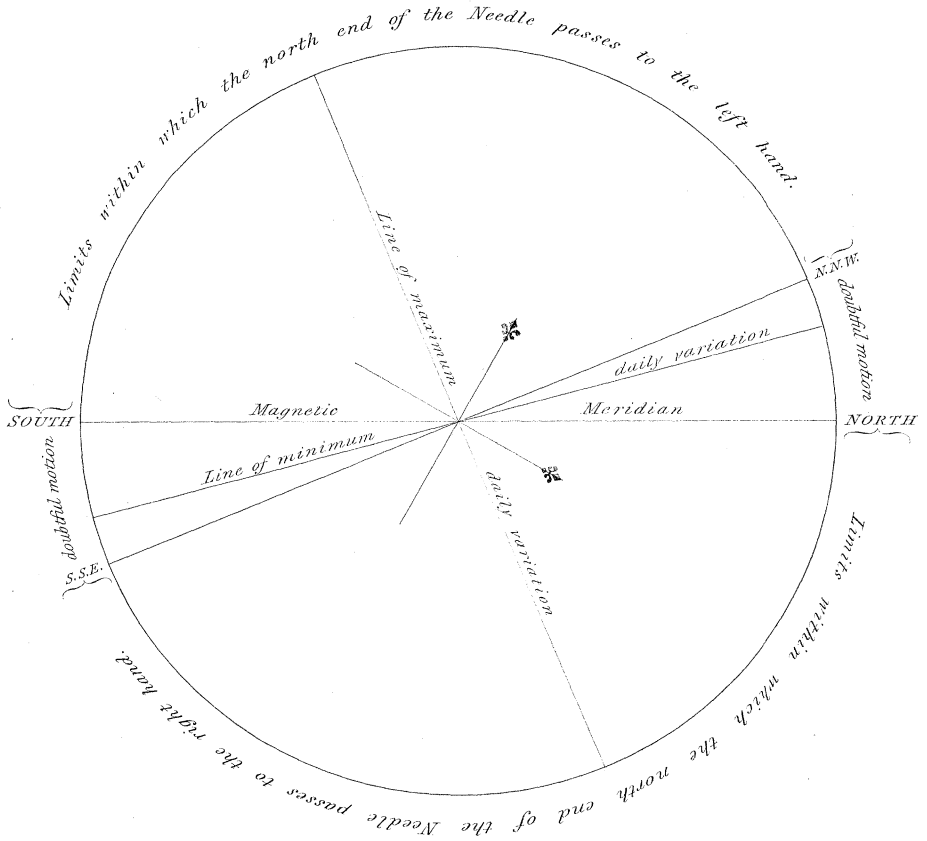
No perceptible motion.

No motion to 2 o'clock this day. The needle then removed.

North end N.N.W.			
Hours.	1st Day.	2nd Day.	3rd Day.
h. m.	° ′	° ′	
6 0	0 0	0 0	
7 0	+ 0 6	0 0	
8 0	— 0 5	— 0 10	
9 0	— 0 25	— 0 25	
10 0	— 0 30	— 0 30	
10 30	— 0 45	— 0 40	
11 0	— 0 45	— 0 55	
11 30	— 1 0	— 1 10	
12 0	— 1 10	—	
1 0	— 1 0	— 1 10	
2 0	—	— 1 5	
3 0	— 1 0	—	
4 0	— 1 0	—	
5 0	—	— 0 45	
6 0	—	— 0 40	
7 0	— 0 50	— 0 40	
8 0	— 0 45	— 0 20	
9 0	— 0 30	— 0 20	
10 0	— 0 10	—	
11 0	— 0 0	—	

No observation on the 3rd day.

* The exact bearing of the needle in this case was N. 16° W. and S. 16° E.


Limits within which the north end of the Needle passes to the left hand.
Line of maximum
daily variation
W.N.W.
doubtful motion
NORTH
Magnetic
Meridian
SOUTH
Line of minimum
daily variation
doubtful motion
S.S.E.
Limits within which the north end of the Needle passes to the right hand.

J.d Basire, sc

From the above results, although the experiments were not made under such favourable circumstances as I could wish, we may draw some very curious, if not important conclusions; such, for instance, as the following. That while the north end of the needle is directed to any point from the south to NNW, its motion during the forenoon is towards the left hand; advancing therefore to some point between the NNW and north; and while it is directed towards any point between the north and SSE it passes to the right hand, that is still to some point between the north and NNW; the south end of the needle at the same time passing of course to some point between the south and SSE; so that it would seem that there ought to be some direction between those limits, viz. between the N and NNW, and the S and SSE, in which the daily motion is zero, or at least a minimum, (see Plate XXIII.): but whether this is a fixed direction during the year, or whether it has any vibratory motion as the sun changes its declination, or even during his daily course, is a question which cannot be decided without a much longer course of experiments than those I have here the honour to present.

It is also questionable, whether the direction of this line of no daily variation is the same in different parts of the world; a point on which I hope to obtain some information in the course of the present year. Mr. FOSTER,* of H. M. S. Griper,

* I am already highly indebted to this Gentleman for the accurate and satisfactory observations he made during the recent voyage of H. M. S. Conway, under the command of Captain BASIL HALL, on the method I had the honour to propose for correcting the local attraction of vessels; and it is with great pleasure that I find he has been directed by the Admiralty to continue his attention to them in the present voyage of the Griper. My best thanks are also due to Captain HALL, for the facilities he afforded in the instance above mentioned, and for the judgment

having very obligingly undertaken to repeat my experiments at Spitzbergen, during the stay of the vessel at that place for the pendulum experiments; and from which we may hope to derive some interesting deductions, particularly in reference to the influence of the direction of the solar rays; for it is clear from the experiments reported in the preceding table, that the amount of the deviation does not entirely depend upon the moment when the heat of the sun is the greatest, as has been generally imagined; for the time of the maximum deviation varies from eleven o'clock in the morning to four o'clock in the afternoon, according to the direction in which the needle is pointed, and to other circumstances that will be mentioned in the conclusion of this article. Mr. CHRISTIE's observations are also of a kind to throw great light on this subject.

Another conclusion, which I think we are justified in drawing from the above experiments, is, that the daily change is not produced by a general deflection of the directive power of the earth, but by an increase and decrease of attraction of some point situated between the north and NNW, or between the south and SSE (see the figure above referred to); for I cannot conceive any other hypotheses that will account for two needles, situated as there shown, both approaching and both receding at the same time to and from the line of no daily variation; nor for the total suspension or equivocal vibratory motion of a needle when placed towards this direction.

I am sorry, that not foreseeing at the commencement of

with which he selected the most appropriate situations for submitting that method to the test of actual experiment.

my experiments, the length to which I should carry them, I did not, from the first, register the temperature and state of the atmosphere; for from certain notes of this kind made lately, it appears to me that the quantity of daily change depends in a greater degree on the intensity of the solar light, than on the mere temperature of the day; although it is certain, from some recent experiments by Mr. CHRISTIE, that the change of temperature of the air, during the day, has a much greater effect upon the intensity of action in the opposing magnets, than I could possibly have imagined.

On the daily variation of the dipping needle.

Notwithstanding my observations on the daily change of this instrument have not been so successful as those on the horizontal needle, yet it will be proper to say a few words on the subject of the experiments, although I do not intend, in the present instance, to give any numerical results; those I have obtained not being so uniform as I could wish, nor such as to justify their publication.

The instrument I employed was made by Messrs. W. and T. GILBERT: it was remarkably free and accurate, and certainly gave results with greater uniformity than any dipping needle I ever used. The needle was only six inches in length, a quarter of an inch broad, and very thin; it performed in the meridian forty-one vibrations in one hundred seconds, when under the usual terrestrial influence; and when masked and adjusted by two magnets placed in the line of the dip, it made only fifteen vibrations and a half in the same time; the power was therefore reduced about eight times.

It is not necessary to explain here the means that I employed, and the precautions I took to ensure stability; it

will be sufficient to observe, that I paid the utmost attention to this essential condition, and that I believe my want of success did not arise from any defect in this part of the process, but from the extreme delicacy of this instrument, and the consequent difficulty in adjusting it when under the influence of the neutralizing magnets. I tried its action for three weeks in the house, but the jarring of doors and other circumstances prevented me from drawing any conclusions; I then removed it to the garden, to a spot well protected by trees and shrubs, and fixed the entire apparatus to my garden wall, which is exactly in the magnetic meridian; and farther sheltered the whole in the best way I could from the effects of the wind and weather. Indeed the only inconvenience was that I could not leave the needle out in the night, and could therefore only notice what took place in the day time, and this, as I have said above, was not so uniform as I could have desired.

In general a motion commenced soon after the instrument was adjusted in the morning; but it was not of that gradual and progressive kind which indicated an uniformly increasing or decreasing power, as in the other instrument; it passed, for instance, suddenly from one half or quarter degree, to another more or less, and which sometimes in the course of the day would give a difference in the dip to the amount of a degree and a half, or even more, but I seldom saw in it a tendency to return; although when I vibrated it towards night, it commonly took up its morning position. I made these observations with the needle in various directions, viz. with the face of the instrument to the east, west, north, south, &c. but in every case I obtained the same sort of daily motion. The question, therefore, respecting the law of va-

riation of this instrument, still remains to be submitted to fixed principles, although there can be no longer any doubt that it is subject to a daily change.

On a curious anomaly observed between the daily variations in-doors and in the open air.

I have already mentioned that I was, at the commencement of my experiments, a good deal embarrassed and delayed by certain anomalies which I noticed between the daily changes of the needle made in the house and in the garden. These may be stated shortly as follows. That in certain positions of the needle towards the east and west, the daily motion, although it proceeded with the same determinate uniformity in both cases, yet it took place in different directions; passing in the one instance from the east, or west, towards the south, and in the other towards the north, at the same corresponding hours of the day, the motion in both instances being equally distinct, regular, and progressive.

After carefully examining every circumstance that might be supposed to be the cause of this singular change, I could only imagine three, that seemed in any way likely to account for it.

1st. Were the two magnets and the compass needle in the two cases in precisely the same relative situation? and if not might not the cause lie in this discrepancy?

2nd. The window of the room was to the northward; was it possible that the light, arriving at the needle in this direction, was the cause of the change?

3d. There was an iron stove in the room, could it be that this was subject to a periodic encrease and decrease of magnetic power?

In order to examine the first of these cases, I measured very carefully the distance, direction, &c. of the compass and magnets while in the garden, and placed them in precisely the same relative situation in the parlour; still the motion in the two cases was reversed.

To examine the second, it occurred to me that if the direction of the motion depended upon that of the light, the needle ought to be wholly stationary in the dark, or when excluded from the solar rays. I therefore kept my room shut for two days, and only examined the needle by the light of a wax taper; but although there was certainly less motion on those days than usual, yet I could come to no satisfactory conclusion; but I still think that farther observations will show that the solar light,* and not the solar heat, is the principal operative agent in producing the daily variation. It remained, however, to examine the third query, which I attempted to do as follows. Having placed the compass in its former situation in the garden, I fixed on one side of it a ten inch howitzer shell, in the same direction with respect to the compass as the stove had in the parlour, and at such a distance that it might produce a sensible deviation in the needle, and which I afterwards adjusted to zero by a slight change in the position of the magnets, thus placing the needle, as I imagined, under similar circumstances in both cases, with respect to local attraction; but, notwithstanding I did in this way actually produce an alteration in the daily mo-

* I am sorry I have not the necessary apparatus for repeating MORICHINI'S experiment on the violet ray; but I would suggest to those who have, that the finest test to which this experiment could be submitted, would be to make use of a needle neutralized as above described, by which the magnetic property of the ray, if it possessed any, could not fail of showing itself.

tion, changing its maximum from eleven o'clock in the morning to about four o'clock in the afternoon, yet the direction of the motion was the reverse of what it was constantly found to be in-doors; the cause therefore of this perplexing anomaly still remains to be discovered.

It is proper to observe that Mr. CHRISTIE, having made some of his observations in-doors, and some in his garden, on two compasses at the same time, found the same reversion of motion in the two cases. His house is a mile distant from mine; he has no stove in the room in which the in-door experiments were made; and the only resemblance of situation is, that his window, like mine, is towards the north. It should be farther added, that this confirmation of the singular anomaly in question did not arise from his simply repeating my experiment, but grew naturally out of the particular mode he had adopted to prosecute the enquiry; our experiments, with the exception of the first suggestion, are independent, and therefore, where they both lead to the same result, they may be considered as confirming the accuracy of each; and where there is any difference, they will at least point out those circumstances which require farther investigation.

P. S. The experiments to which I have alluded in page 337, made since this article was written, seem to indicate that this anomaly, as well as the circumstance there mentioned, may be occasioned by the daily varying intensity of the opposing magnets.