# Horizontal Pendulum Diagram obtained during a Storm.

BY

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With Plates III-V.

**1.** Pl. III is a half size reproduction of the diagram given by an EW component horizontal pendulum during about $24\frac{2}{3}$ hours from the 10th, 10h 5m a.m., to the 11th, 10h $44\frac{1}{2}$m a.m., Oct. 1904. The instrument, which is set up in the brick "Earthquake-proof House" in the University Compound (Hongo, Tokyo), has the following specifications:—

Length of the strut, or the horizontal distance between the pendulum axis and the centre of the heavy bob $=L=75$ cm;

Period of the pendulum when suspended vertically $=T_0=1.74$ sec.;

Period of the horizontal pendulum as actually set up $=T=33$ sec.;

Multiplication ratio of the recording pointer $=n=20$;

1 mm displacement of the writing index, or $r$,

$$=L\times n\times \sin 1''\times\frac{T^2}{T_0^2}=0.''0385.$$

**2.** ***The weather on the 10th and 11th at Tokyo.*** The barometric pressure* was 770 mm at 10 p.m., on the 9th, thence gradually decreasing to 758.2 mm at 4 p.m., on the 10th. The pressure, which reached the minimum of 757.5 mm at 6 o'clock on the

* With temperature, gravity, and sea-level corrections.

latter day, remained low and less than 758 mm till the midnight. Thereafter the pressure began to increase, reaching the maximum value of 776.8 mm at the midnight of the following day. The wind velocity, which was on the morning of the 10th between about 8 and 10 metres per second, increased at 3 p.m. to 12.6 metres per sec. and reached the maximum value of 14.8 metres per second, at 7 p.m. on the same day. The velocity remained greater than 13.7 metres per sec. till 10 p.m., thence gradually decreasing to 1.6 metres per sec. at 7 a.m. on the following morning. The hourly values of the pressure and wind velocity during Oct. 10th and 11th, were as follows.

BAROMETRIC PRESSURE AND WIND VELOCITY AT TOKYO. OCT. 10 AND 11, 1904.

| Hour. | Barometric Pressure. | | Wind Velocity. | | Hour | Barometric Pressure. | | Wind Velocity. | |
|---|---|---|---|---|---|---|---|---|---|
| | 10th | 11th | 10th | 11th | | 10th | 11th | 10th | 11th |
| | mm. | mm. | m/sec. | m/sec. | | mm. | mm. | m/sec. | m/sec. |
| 1 a.m. | 767.3 | 757.3 | 6.5 | 6.5 | 1 p.m. | 761.1 | 761.2 | 8.8 | 9.7 |
| 2 „ | 66.6 | 57.8 | 6.3 | 4.8 | 2 „ | 59.4 | 61.3 | 9.4 | 9.4 |
| 3 „ | 66.6 | 58.1 | 7.4 | 5.9 | 3 „ | 58.4 | 61.7 | 12.6 | 9.0 |
| 4 „ | 65.1 | 58.5 | 8.5 | 3.9 | 4 „ | 56.9 | 62.3 | 11.9 | 6.1 |
| 5 „ | 65.5 | 59.1 | 8.1 | 3.5 | 5 „ | 56.5 | 63.2 | 13.9 | 4.6 |
| 6 „ | 65.0 | 59.6 | 8.1 | 2.4 | 6 „ | 56.2 | 63.9 | 13.0 | 2.4 |
| 7 „ | 65.4 | 60.7 | 9.0 | 1.6 | 7 „ | 56.6 | 64.5 | 14.8 | 2.8 |
| 8 „ | 64.4 | 61.1 | 9.9 | 1.8 | 8 „ | 56.6 | 64.9 | 14.6 | 1.5 |
| 9 „ | 64.0 | 61.5 | 9.4 | 2.8 | 9 „ | 56.7 | 65.4 | 14.3 | 0.9 |
| 10 „ | 62.4 | 61.5 | 9.4 | 6.1 | 10 „ | 56.7 | 65.4 | 13.7 | 0.9 |
| 11 „ | 62.1 | 61.4 | 9.2 | 8.5 | 11 „ | 56.7 | 65.4 | 10.3 | 1.1 |
| Noon | 61.7 | 61.3 | 10.1 | 8.5 | Midnight | 56.7 | 65.5 | 9.9 | 1.1 |
| | | | | | *Mean.* | 761.02 | 761.77 | 10.38 | 4.41 |

It will be observed that the fall of the barometric pressure during the 10th and 11th was 12.5 mm, while the maximum wind velocity was 14.8 metres per sec., so that the storm on these two days was

not one of exceptional violence. The precipitation on the 10th was, however, very great, amounting to 126.1 mm. On the 11th there was practically no precipitation.

As shown in Pls. IV and V, the positions of the low pressure centre at 7 p.m. and at 11 p.m. on the 10th were respectively at distances of 250 km to the SE, and 350 km to the ESE, from Tokyo; the cyclone having thus travelled, within the two above-mentioned hours, in an north-easterly direction and to the east of the place of observation.

**3.** ***Tilting of the ground.***—According to Pl. III, the inclination of the ground toward the east, which began on the morning of the 10th, greatly increased at 7 p.m. and reached the limit at about 10h 15m p.m. on the same day. Thence began the inclination in the opposite sense, which continued till about 4h 40m a.m. on the 11th. The extreme amount of the inclination during these 10 hours amounted on the original diagram to 93 mm, which corresponds to an angular motion of about $3''\frac{1}{2}$. On the 11th, there was practically no tilting motion between 4h 40m a.m. and 7h 25m a.m. After the latter epoch, there began a slight inclination toward the west, till at 10 a.m., when the index of the tiltometer returned nearly to the same position as at the same hour on the preceding day.

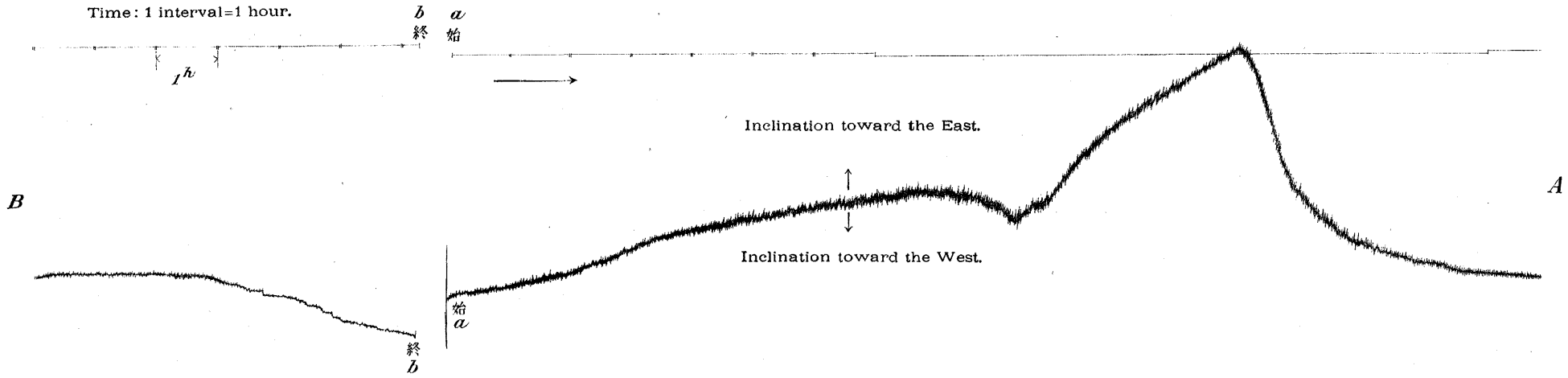
It will thus be seen that the marked inclination of the ground toward the east occurred during those hours when the barometric pressure was low and the wind was strongest, the ground having regained its original position with the rise of the barometre. A fact to be noted in this connection is that the low pressure centre which caused the eastward inclination, pased to the east of Tokyo. Now it might be supposed that the ground, when subject to a fall of the pressure, will be elevated by a certain amount so as to adjust itself to equilibrium. If such be true, the inclination of the ground during the passage of the cyclone under consideration ought to have been directed toward the west, which was not the case. The explanation of this apparently anomalous phenomenon is probably to be found in the accumulation of

sea waters under the low pressure centre to a degree greater than the amount of the diminution of the atmospheric pressure, thereby creating an increase in the resultant pressure at the sea bottom.

Tokyo. Jan., 1905.

# Horizontal Pendulum Record obtained during a Storm.

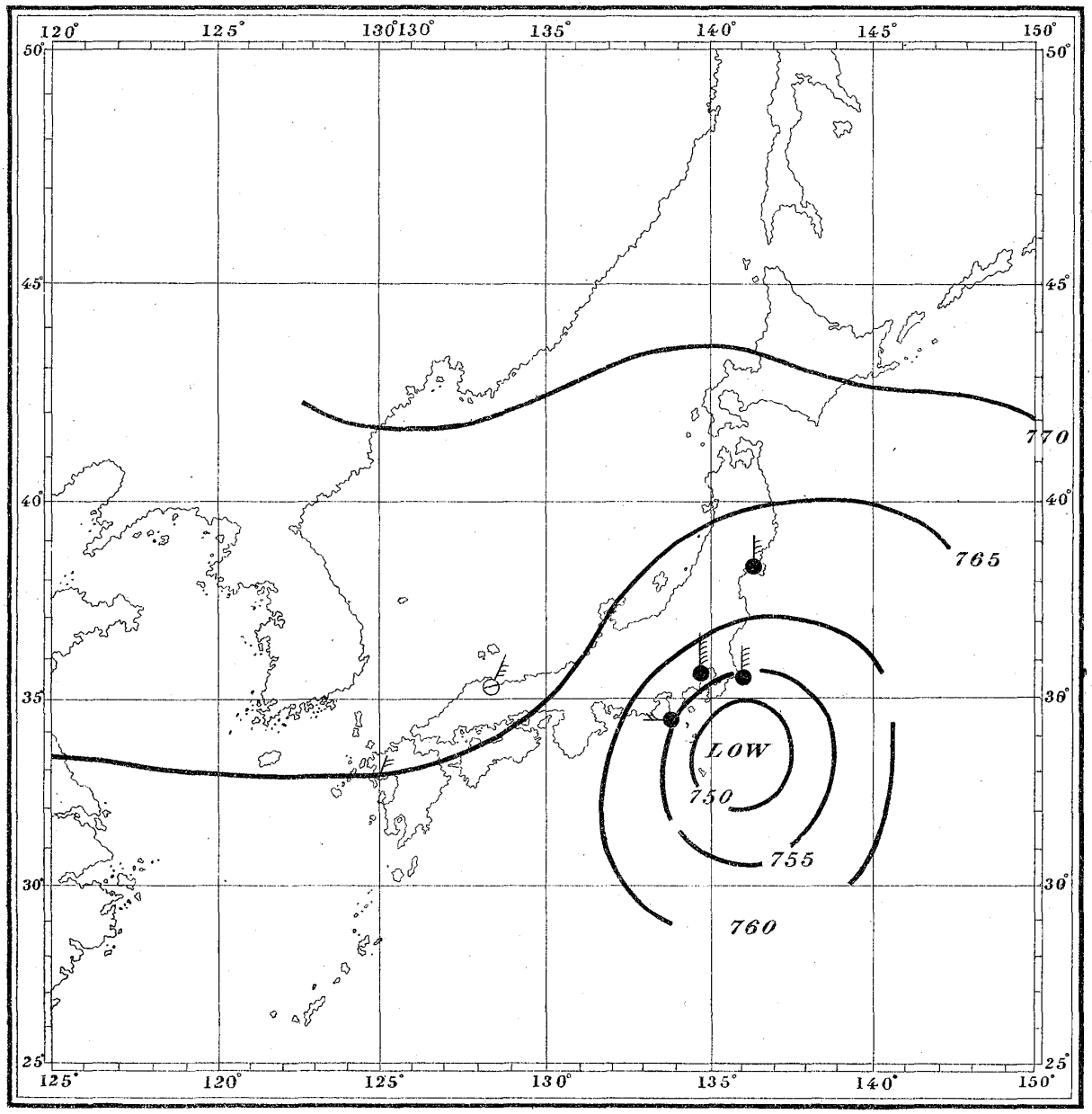
Oct. 10th--11th, 1904.




*(A) is continued to (B)*

*a*..... Commencement: Oct 10, 1904; 10h 24m A.M.
*b*.....End : „ 11, „ ; 11 23 „

**Position of the Low Pressure Centre at 7 p.m., Oct. 10, 1904.**



**Position of the Low Pressure Centre at 11 p.m., Oct. 10, 1904.**
The arrow indicates the path of the centre.