

## DIAGRAMS OF EARTHQUAKES RECORDED AT THE CHIRI-KYOKU IN TOKYO.

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By JOHN MILNE.

[Read May 29th, 1890.]

Through the kindness of Mr. Arai Ikunosuke, director of the Imperial Meteorological Bureau in Tokyo, I have been enabled to reproduce the following as examples of diagrams taken by the Gray-Milne Seismograph, which has been the standard instrument in that department for many years. The instrument is one of the first constructed, and has the objection that if an earthquake continues for more than 120 seconds, which is the time taken for the revolution of the recording drum, one portion of the diagram may be superimposed upon another.

In more modern types of this instrument this objection has been overcome by the record being taken upon a continuously running band of paper. For a description of the instrument see *Trans. Seis. Soc.* Vol. XII., p. 33, or *Philosophical Magazine*, April, 1887.

September 28th, 1885.

5.27.43 a.m.

Period 2.2 sec. Amp. 11.1 mm. Direction E. 17° S. Duration 4 min.

The origin of this disturbance, which shook a land area stretching at least 150 miles to the west, was probably in the sea, S.W. from Tokio.

October 26th, 1885.

10.41.11 p.m.

Period 2.9 sec. Amp. 1.9 mm. Direction N.  $45^{\circ}$  W.

Duration 4 m. 48 sec.

The centre was about 60 miles S.S.W. from Tokio. Land area shaken, 978 square *ri*.

December 28th, 1885.

10.6.30 p.m.

Period 1.8 sec. Amp. 3.3 mm. Direction E.  $11^{\circ}$  N.

Duration 3 min. 40 sec.

Tokio appears to have been about the centre of the disturbance, which had a radius of about 80 miles.

January 15th, 1887.

6.51.59 p.m.

Horizontal motion.—Period 2.3 sec. Amp. 19.2 mm. Direction E.  $34^{\circ}$  N.

Vertical motion.—Period 0.8 sec. Amp. 5.5 mm. Duration 10 minutes.

The origin of this earthquake was a few miles to the west of Yokohama. The area shaken was 5,364 square *ri*, extending from Nagoya to the west, nearly to Niigata to the north and to Sendai to the north-east. This disturbance, which created some damage in Yokohama has been fully described by Professor Sekiya (see Vol. XI.).

April 29th, 1887.

11.12.10 a.m.

Period 3.0 sec. Amp. 1.2 mm. Direction S.  $22^{\circ}$  E. Duration 3.0 min.

This disturbance was felt all over the country from Kiushiu to Owari. Beyond this it was not felt until we reach the eastern side of the Hakone range, where the Tokio area is shaken, the disturbed district being elliptical with a major axis 60 miles in length stretching N. and S. The area shaken was 7,862 square *ri*.

September 5th, 1887.

3.23.23 a.m.

Horizontal motion.—Period 2.3 sec. Amp. 2.57 mm. Direction S.E.-N.W.

Vertical motion.—Period 0.8 sec. Amp. 6.5 mm. Duration 6.0 min.

The area shaken was 5,498 square *ri*, and extended from Shidzuoka to Niigata and then beyond Sendai. The centre was about 60 miles S.E. from Tokio.

February 2nd, 1888.

1.15.15 p.m.

Horizontal motion.—Period 3.7 sec. Amp. 13.0 mm. Direction W.N.W.-E.S.E.

Vertical motion.—Period ——. Amp. 0.5 mm. Duration 3 m. 48 sec.

The area shaken, which was 3,415 sq. *ri*, extended from Odawara to Sendai.

The origin appears to have been about 60 miles east from Tokio.

February 2nd, 1888.

3.41.27 p.m.

Period 2.4 sec. Amp. 3.8 mm. Direction W.S.W.-E.N.E.  
Duration 4 m. 5 sec.

The land area shaken was 2,635 sq. *ri*. The disturbance was feeble and only felt at a few places. The origin appears to have been 60 miles east of Tokio.

April 29th, 1888.

10.0.33 a.m.

Horizontal motion.—Period 0.8 sec. Amp. 5.6 mm. Direction S.E.-N.W.

Vertical motion.—Period 0.6 sec. Amp. 1.5 mm. Duration 8 minutes.

The area shaken was 5,078 square *ri* extending from near Nagoya to Sendai. The centre was near Tokio.

96 DIAGRAMS OF EARTHQUAKES RECORDED

November 3rd, 1888.

8.13.33 a.m.

Horizontal motion.—Period 0.4 sec. Amp. 1.9 mm. Direction S.W.-N.E.

Vertical motion.—Period 0.4 sec. Amp. 0.5 mm. Duration 4 m. 30 s.

The land area shaken was 737 sq. *ri*, the centre being about 40 miles E. of Tokio.

January 1st, 1889.

7.5.30 p.m.

Horizontal motion—Period 0.15 sec. Amp. 1.1 mm. Direction S.W.-N.E.

Vertical motion.—Period 0.3 sec. Amp. 0.5 mm. Duration 1 m. 55 sec.

The land area shaken was 3,432 square *ri* extending from Shidzuoka to Sendai. The centre was about 20 miles N.W. of Tokio.

February 18th, 1889.

6.09.32 a.m.

Horizontal motion.—Period 2.2 sec. Amp. 20.3 mm. Direction N.W.-S.E.

Vertical motion.—Period 0.6 sec. Amp. 3.7 mm. Duration 6 m. 12 sec.

The land area shaken was 5,749 sq. *ri*, extending from Owari to Mito. The centre was in the bay of Tokio.

March 31st, 1889.

6.42.15 a.m.

Horizontal motion.—Period 2.5 sec. Amp. 3.8 mm. Direction S.S.E.-N.N.W.

Vertical motion.—Period 0.6 sec. Amp. 0.2 mm. Duration 4 min.

The land area shaken was 4,343 sq. *ri*, extending from Nambu to Odawara. The centre was about 120 miles N.E. from Tokio.



April 18th, 1889.

2.07.42 p.m.

Horizontal motion.—Period 1 sec. Amp. 0.8 mm. Direction  
E.S.E.-W.N.W.

Vertical motion.—Period 0.7 sec. Amp. 0.2 mm.

The land area shaken was about 3,052 sq. *ri*, the centre being  
near Oshima.

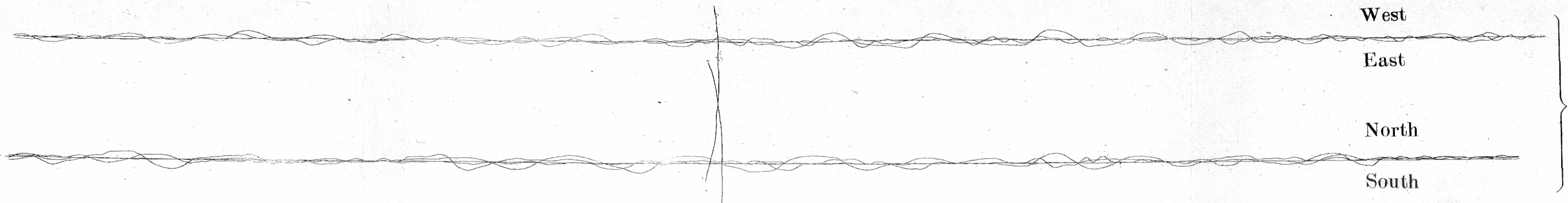
October 13th, 1889.

10.50.24 p.m.

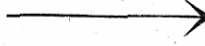
Horizontal motion.—Period 2.0 sec. Amp. 2.2 mm. Direc-  
tion S.E.-N.W.

Vertical motion.—Period 0.6 sec. Amp. 0.4 mm. Duration  
2 min.

The land area shaken was 3,009 square *ri*, extending from  
Shizuoka to Sendai. The centre was about 50 miles north  
of Tokio.



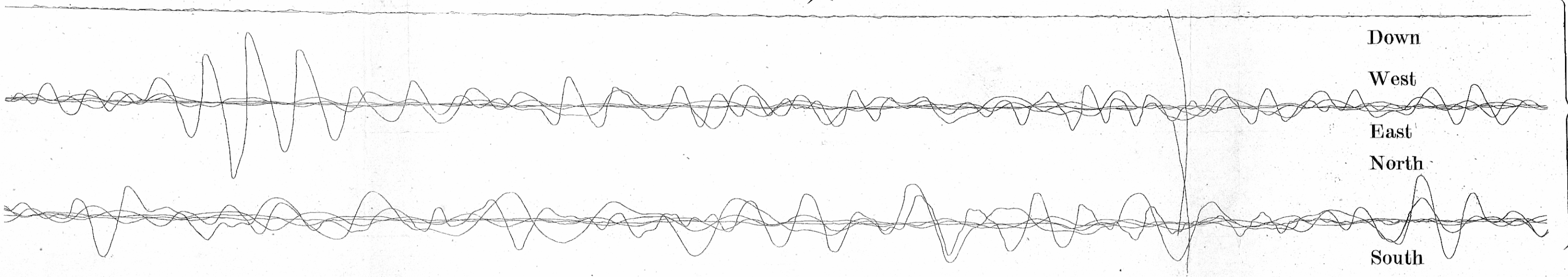
OCTOBER 26th 1885. 10<sup>h</sup> 41<sup>m</sup> 11<sup>s</sup>. ONE REVOLUTION = 110<sup>secs.</sup>



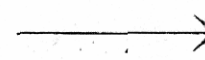
West  
East  
North  
South

**No. 1**

Up



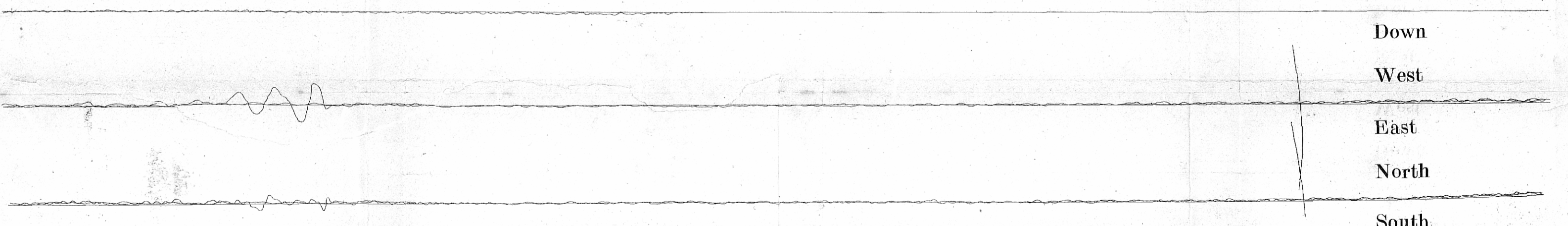
SEPTEMBER 28th 1885. 5<sup>h</sup> 27<sup>m</sup> 43<sup>s</sup> A.M. ONE REVOLUTION = 75<sup>secs.</sup>



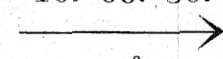
Down  
West  
East  
North  
South

**No. 2**

Up



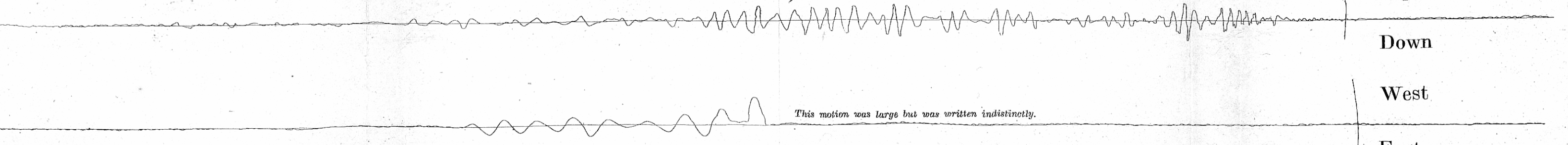
DECEMBER 28th 1885. 10<sup>h</sup> 06<sup>m</sup> 30<sup>s</sup> P.M. ONE REVOLUTION = 118<sup>secs.</sup>



Down  
West  
East  
North  
South

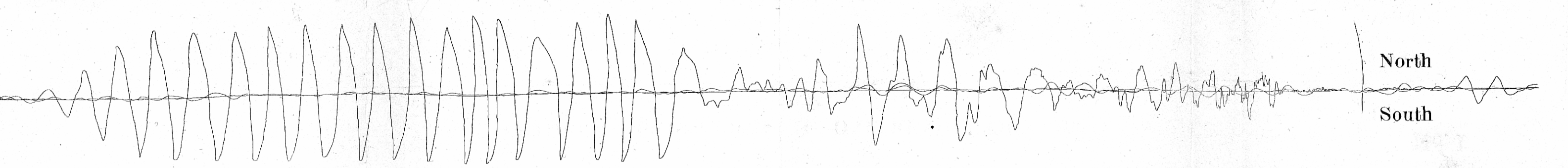
**No. 3**

Up

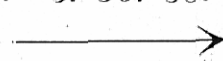


*This motion was large but was written indistinctly.*

Down  
West  
East



JANUARY 15th. 1887. 6<sup>h</sup> 50<sup>m</sup> 59<sup>s</sup> P.M. ONE REVOLUTION = 170<sup>secs.</sup>

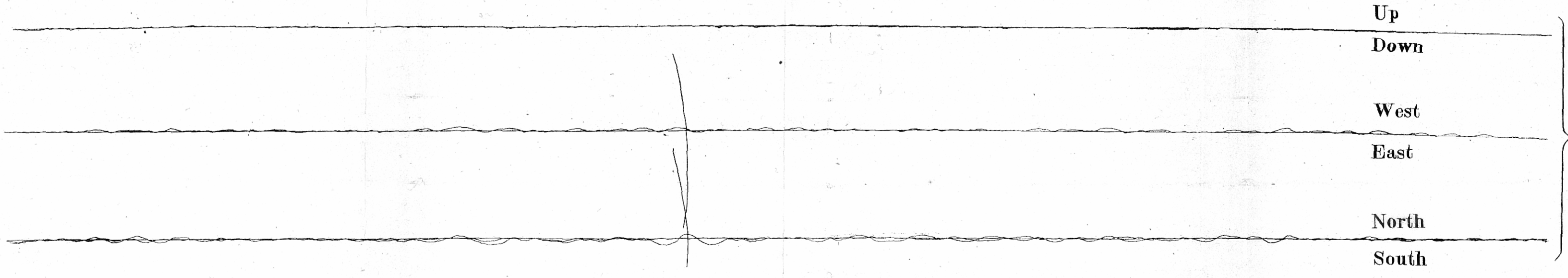


North  
South

**No. 4**

Multiplication { Horizontal 3.  
Vertical 2.

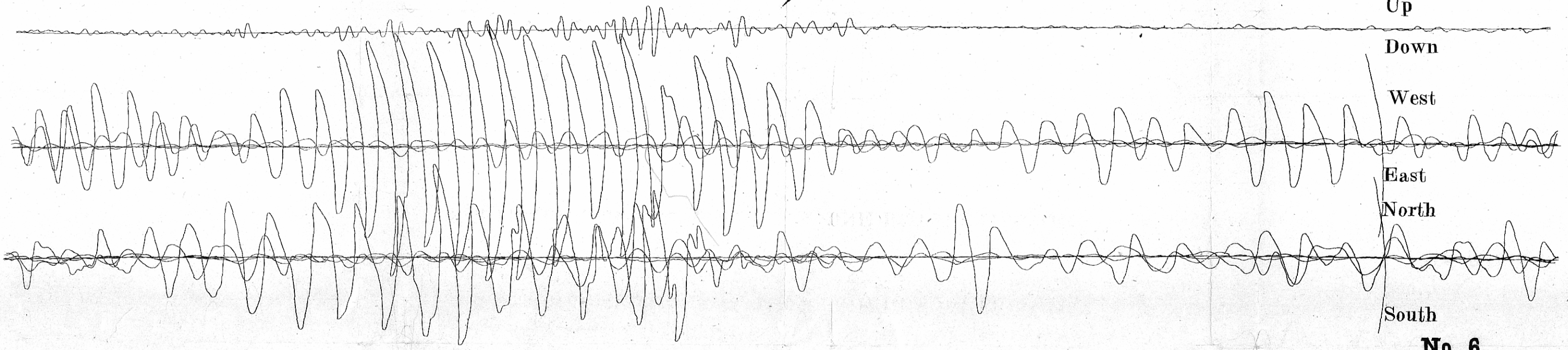




Up  
Down  
West  
East  
North  
South

APRIL 29th 1887. 11. 12. 10. A.M. ONE REVOLUTION = 120<sup>sec.</sup>

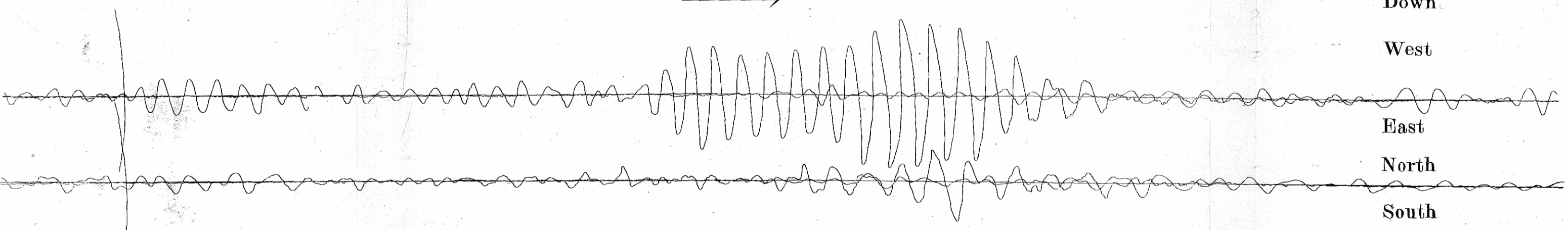
**No. 5**



Up  
Down  
West  
East  
North  
South

SEPTEMBER 5th 1887. 3. 23. 23. P.M. ONE REVOLUTION = 116<sup>sec.</sup>

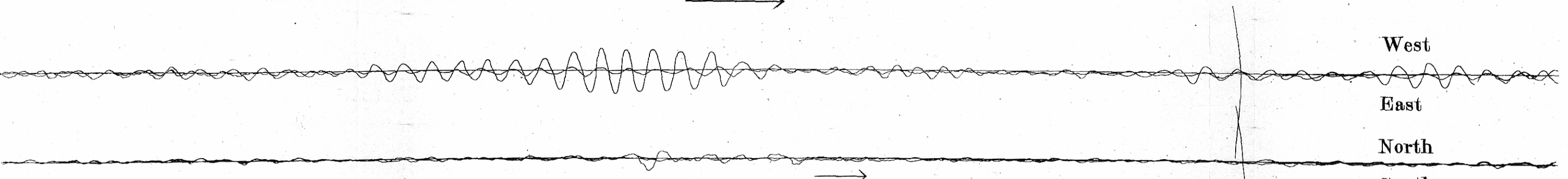
**No. 6**



Up  
Down  
West  
East  
North  
South

FEBRUARY 2nd 1888. 1. 15. 15. P.M. ONE REVOLUTION = 165<sup>sec.</sup>

**No. 7**

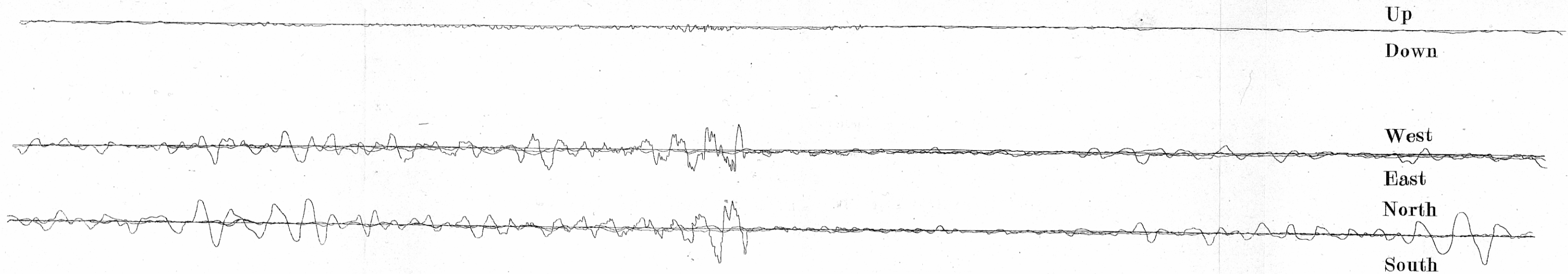


West  
East  
North  
South

FEBRUARY 2nd 1888. 4. 14. 27. P.M. ONE REVOLUTION = 125<sup>sec.</sup>

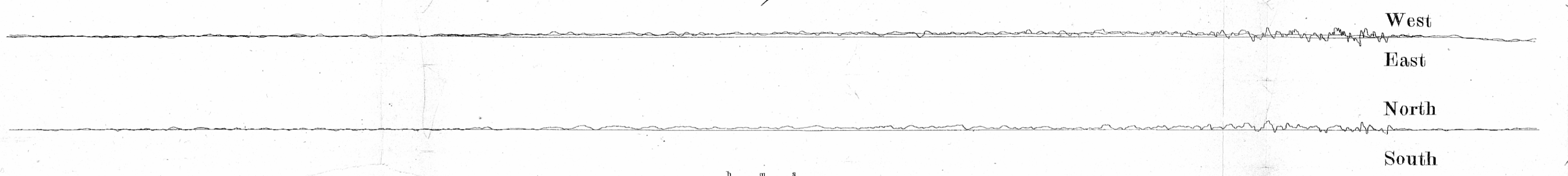
**No. 8**

Multiplication { Horizontal 3.  
Vertical 2.



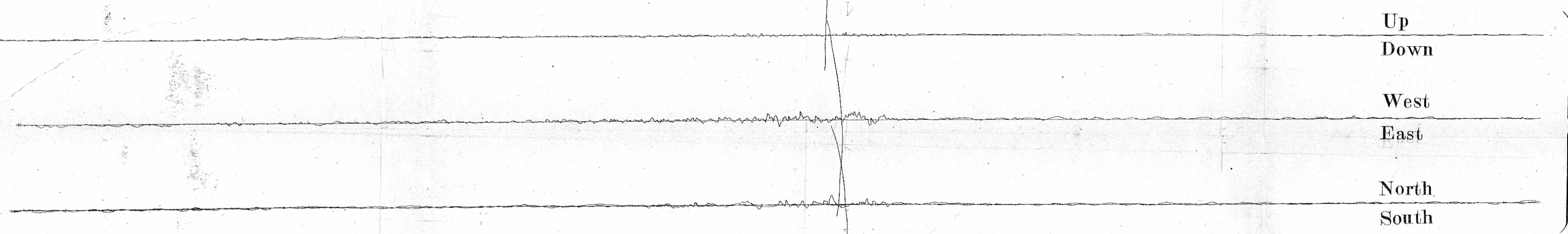
APRIL 29th 1888. 10. 0<sup>h</sup> 33<sup>m</sup> 33<sup>s</sup> A.M. ONE REVOLUTION=164<sup>secs.</sup>

No. 9



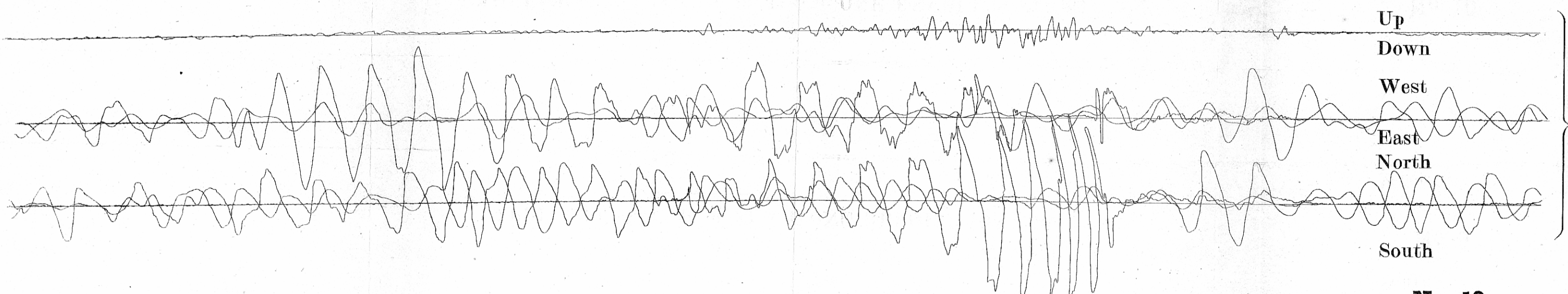
NOVEMBER 3rd 1888. 8. 13. 33<sup>s</sup> A.M. ONE REVOLUTION=162<sup>secs.</sup>

No. 10



JANUARY 5th. 1889. 7. 5. 30<sup>s</sup> P.M. ONE REVOLUTION=115<sup>secs.</sup>

No. 11

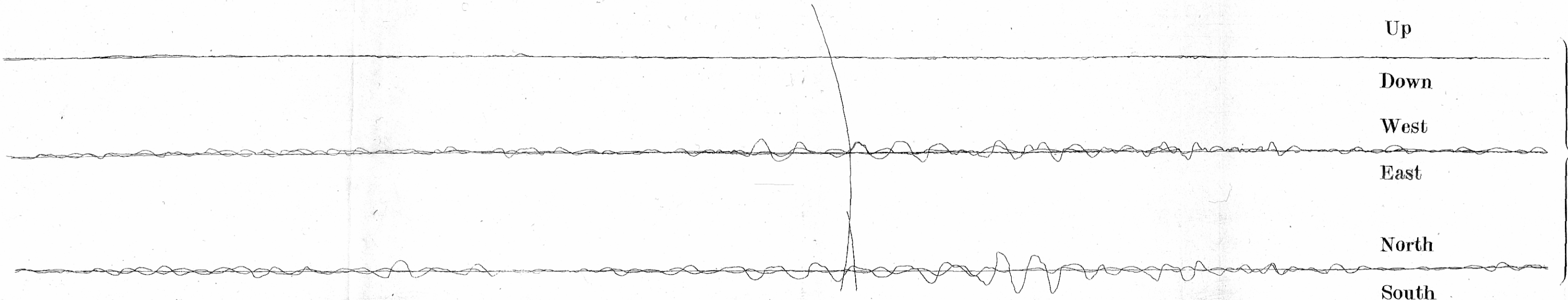


FEBRUARY 18th 1889. 6. 09. 32<sup>s</sup> A.M. ONE REVOLUTION=125<sup>secs.</sup>

No. 12

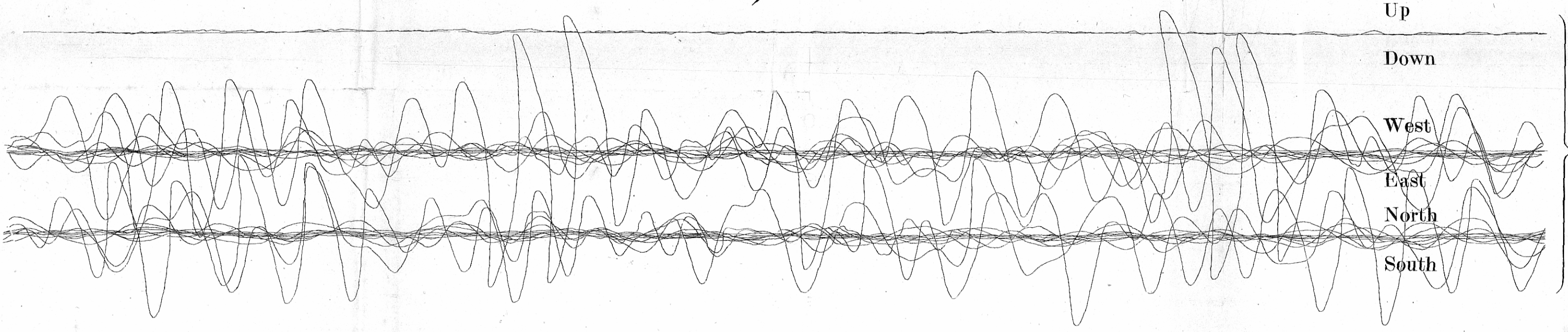
Multiplication { Horizontal 3.  
Vertical 2.





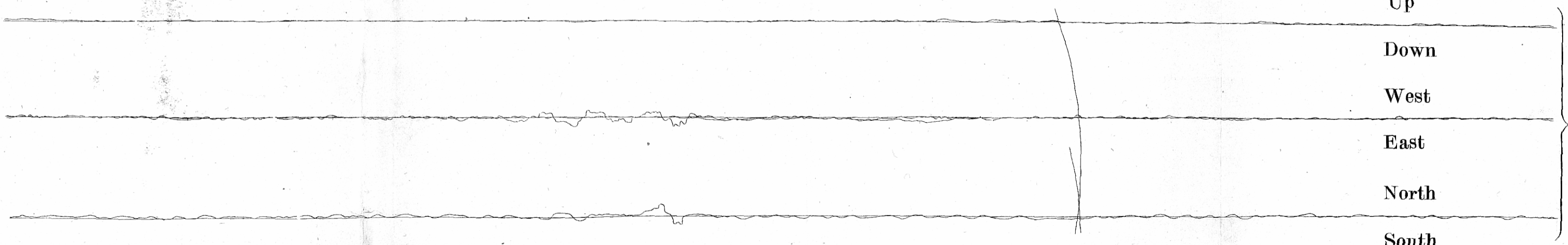
MARCH 31st 1889. 6. 42. 15. A.M. ONE REVOLUTION = 135<sup>secs.</sup>  
 →

No. 13



APRIL 18th 1889. 2. 07. 42. P.M. ONE REVOLUTION = 98<sup>secs.</sup>  
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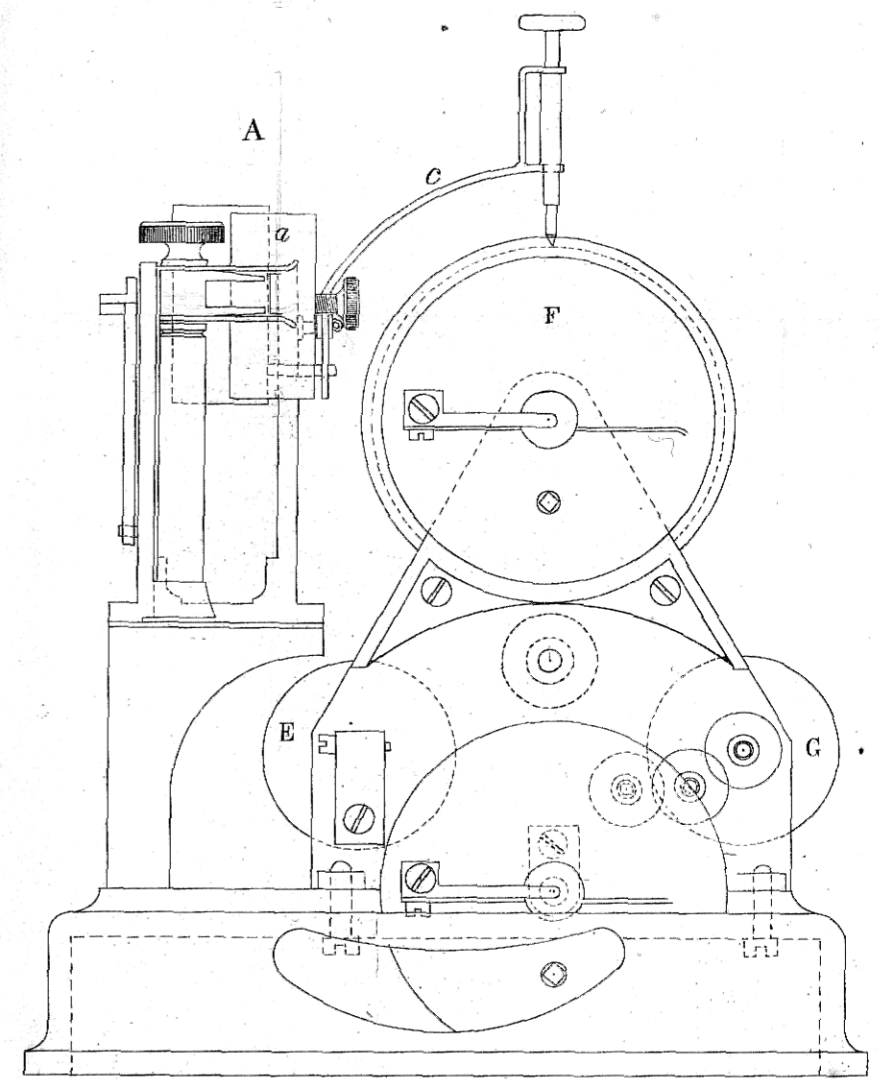
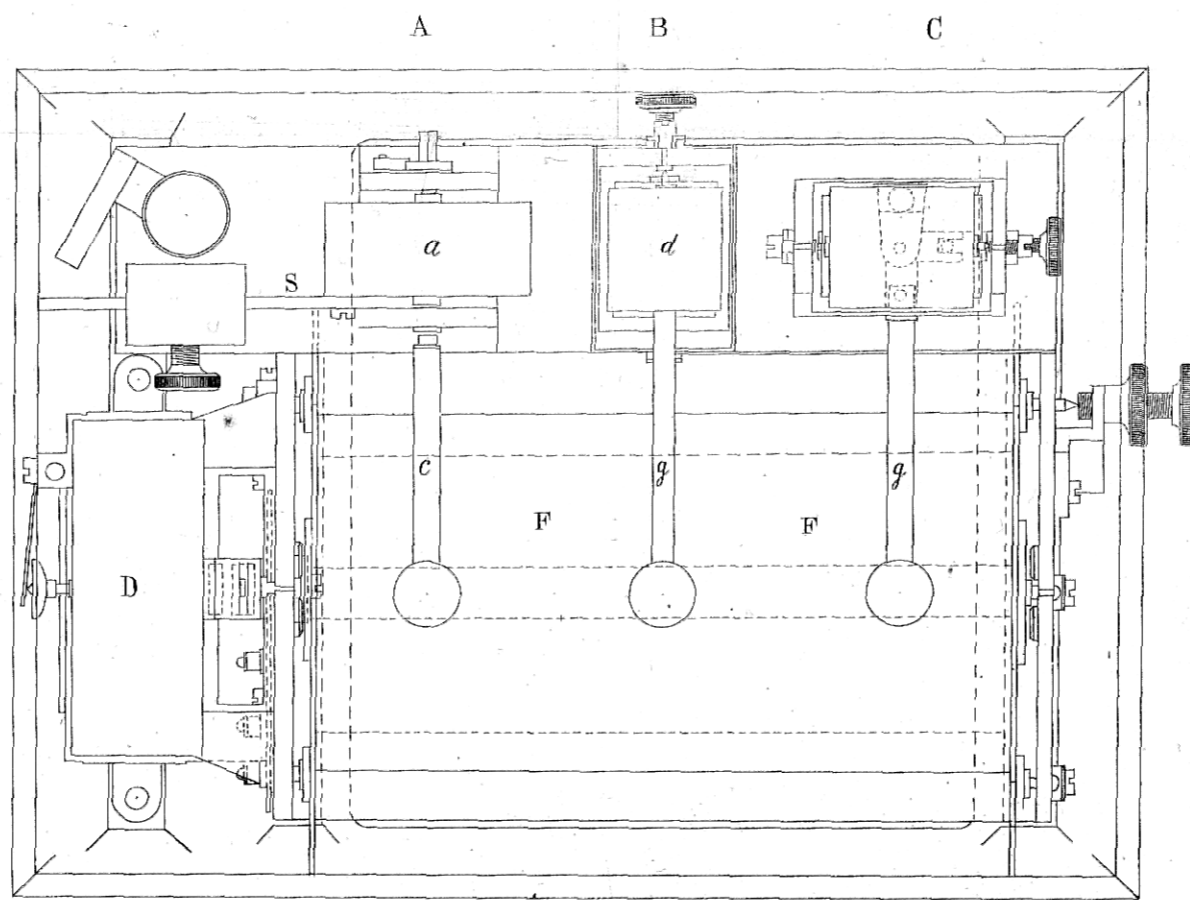
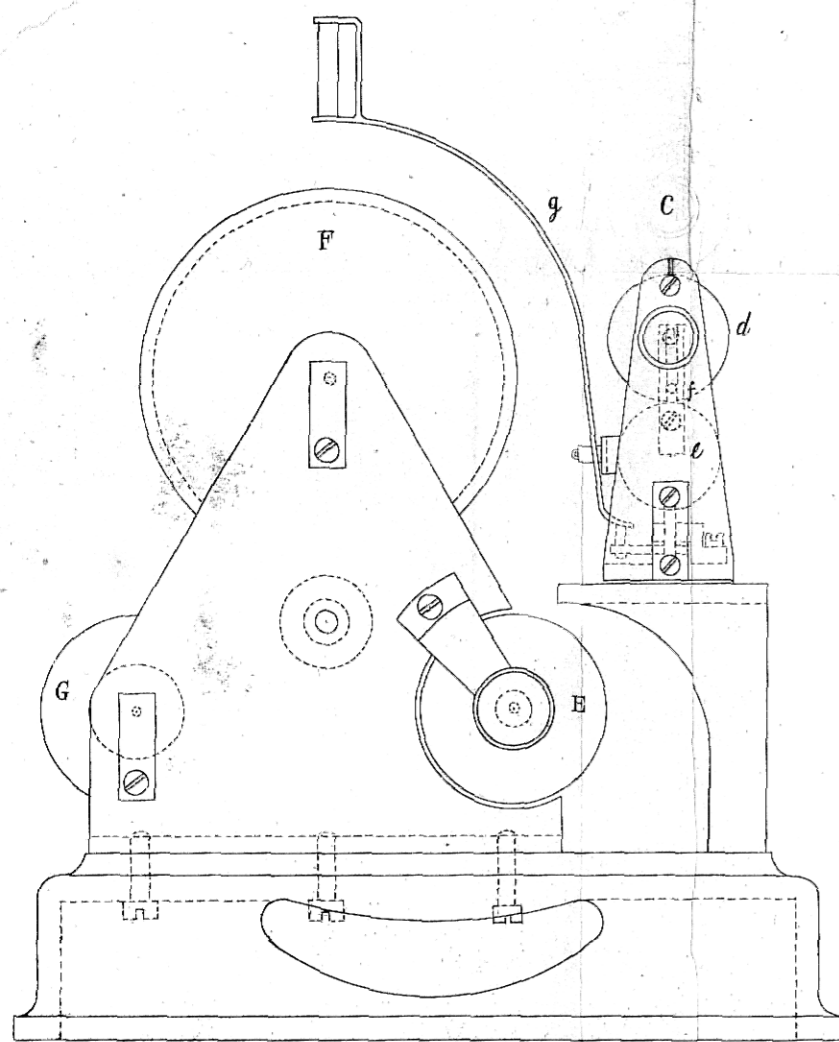
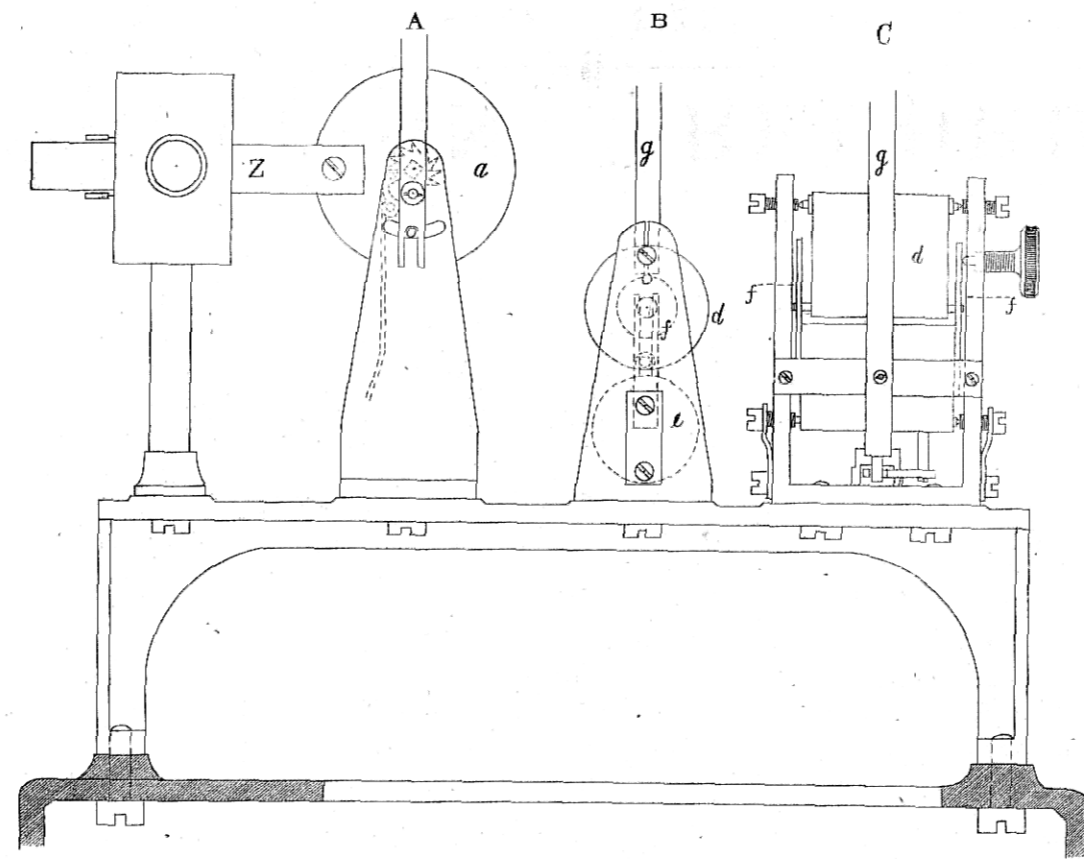
No. 14



OCTOBER 13th 1889. 10. 50. 24. P.M. ONE REVOLUTION = 120<sup>secs.</sup>  
 →

No. 15

Multiplication { Horizontal 3.  
 Vertical 2.



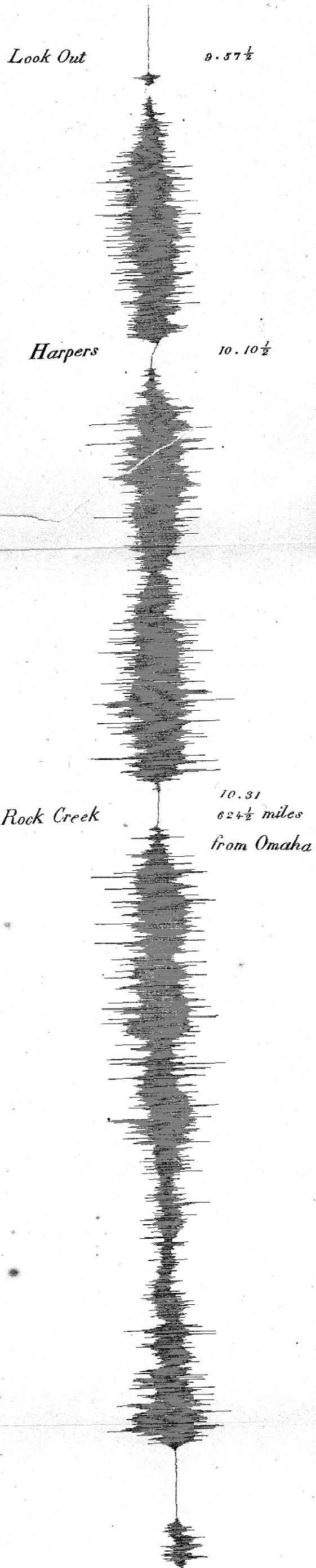
**VIBRATION RECORDER**

HALF SIZE



Oct. 12<sup>th</sup> 1889

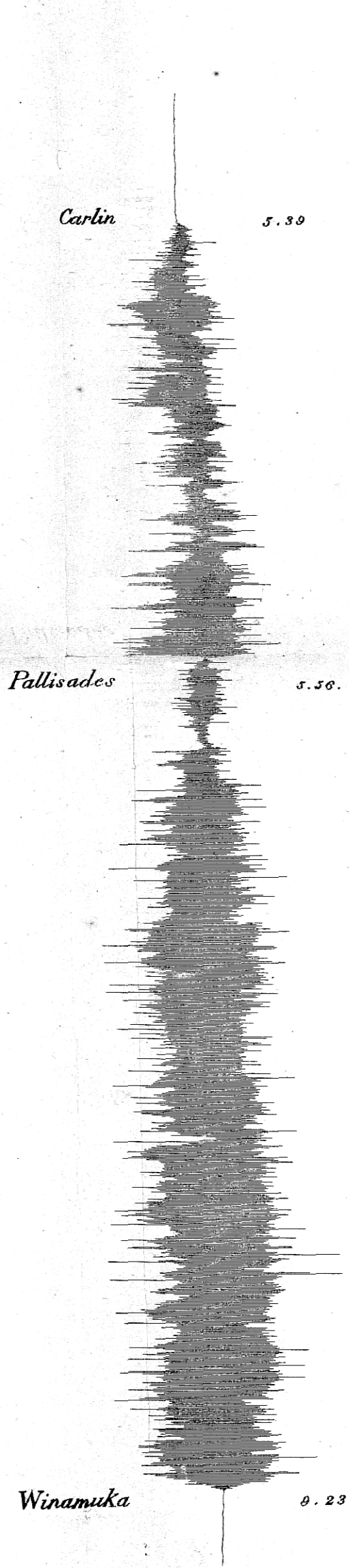
A long delay  
waiting for two  
Cattle Trains to pass.



Aurora 11.10.  
41 miles from Omaha  
UNION PACIFIC  
Pullman "Merlin" Scale 1<sup>in</sup> = 5<sup>min</sup>

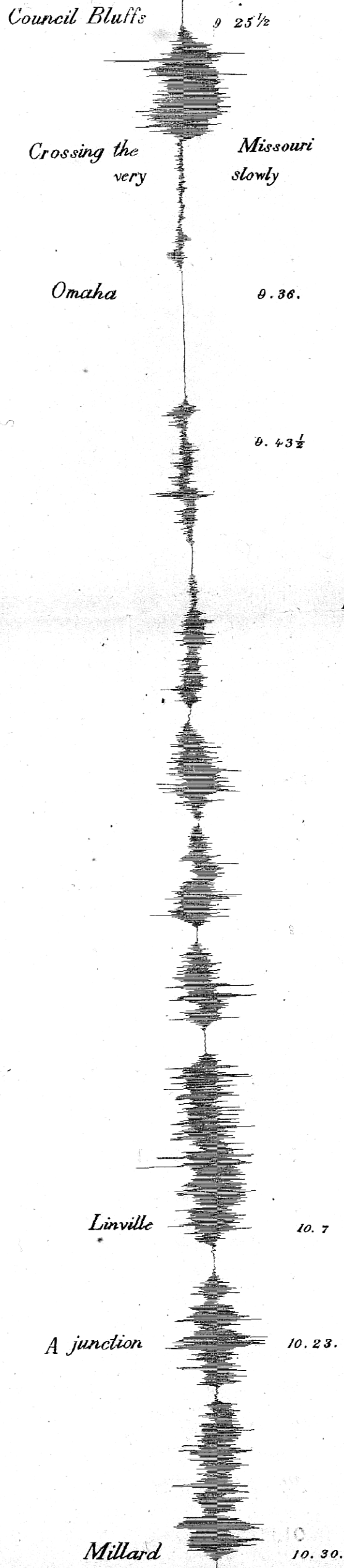
Oct. 13<sup>th</sup> 1889.

Carlin to Butler Mountain



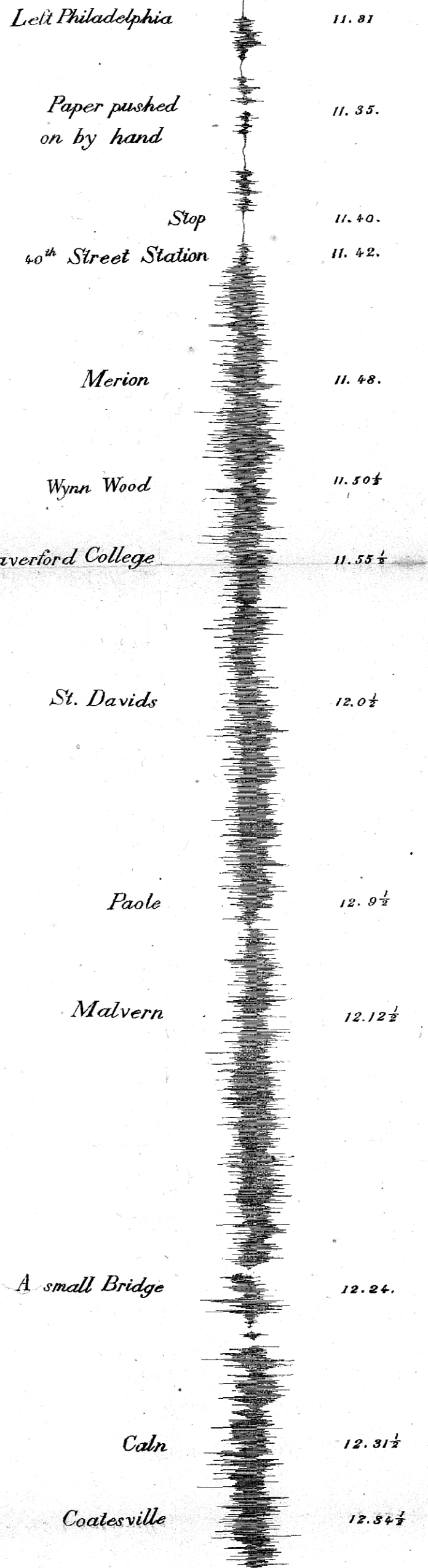
UNION PACIFIC  
Pullman "Quiero"  
Scale 1<sup>in</sup> = 5<sup>min</sup>.

Oct. 11<sup>th</sup> 1889

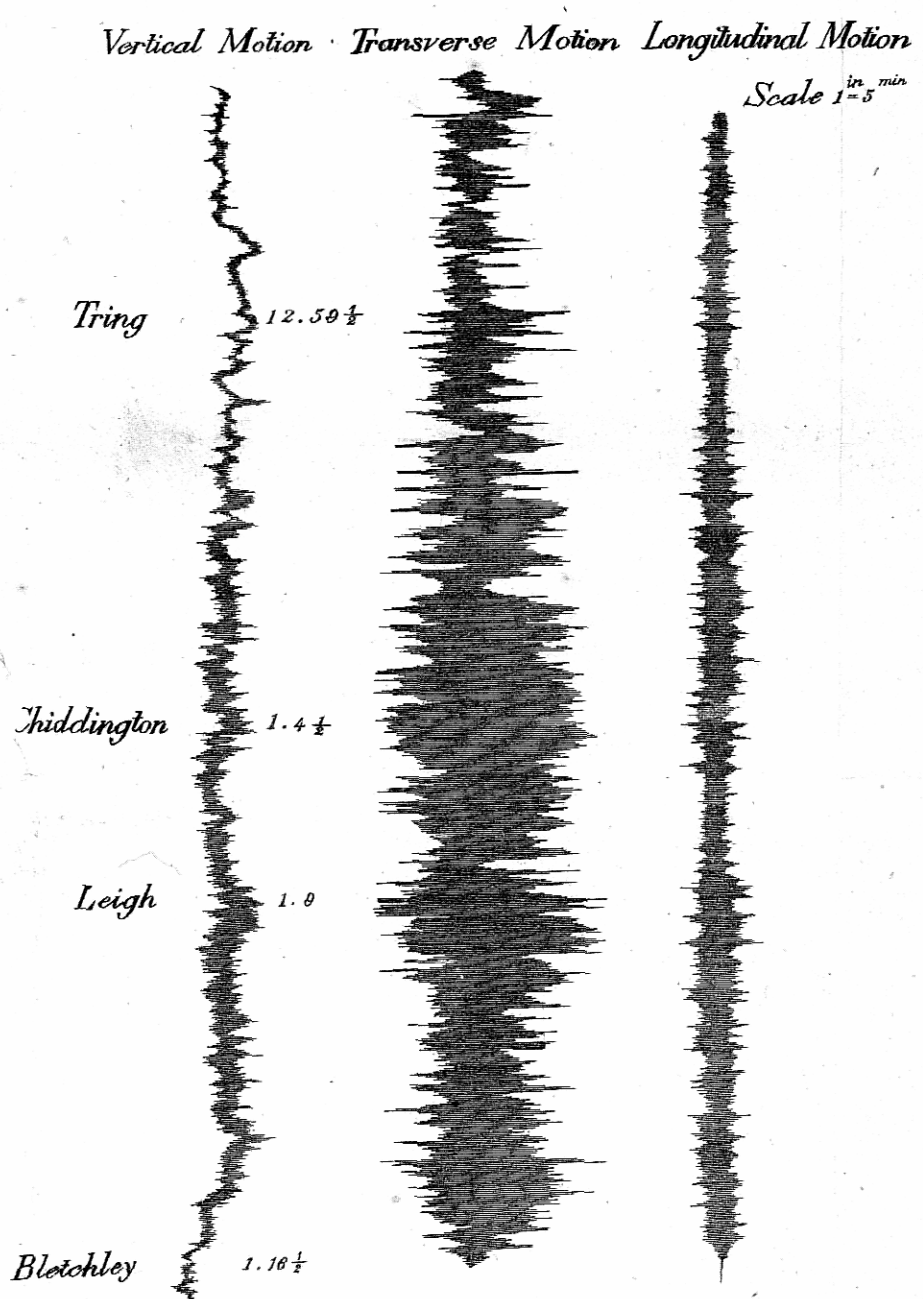


UNION PACIFIC  
Pullman "Merlin"  
Scale 1<sup>in</sup> = 5<sup>min</sup>

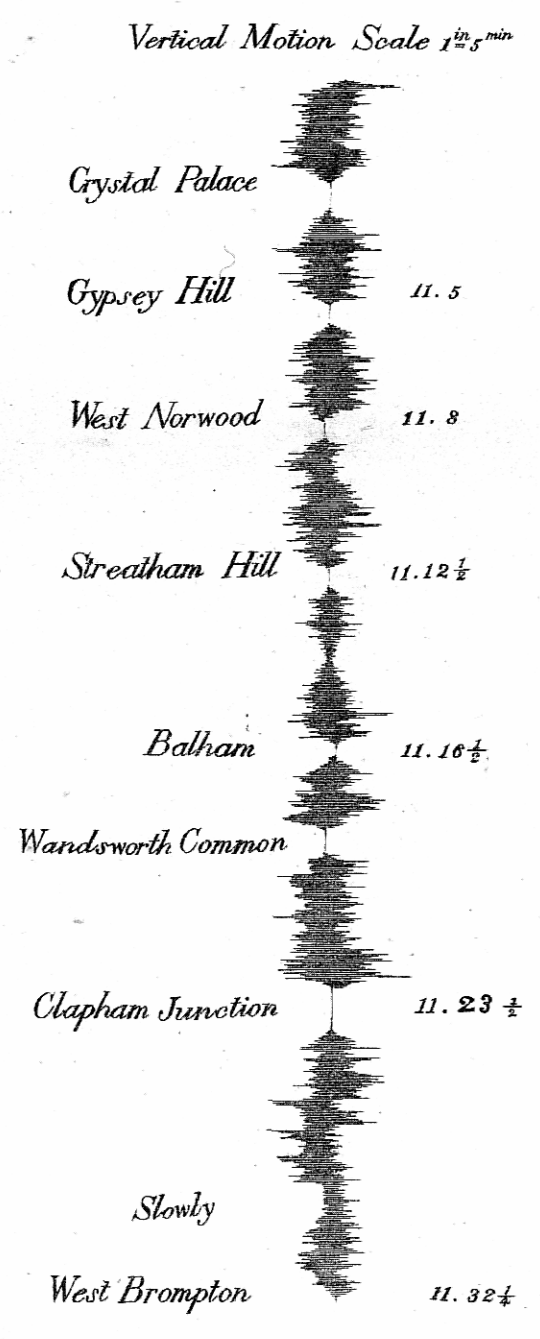
Oct. 9<sup>th</sup> 1889.



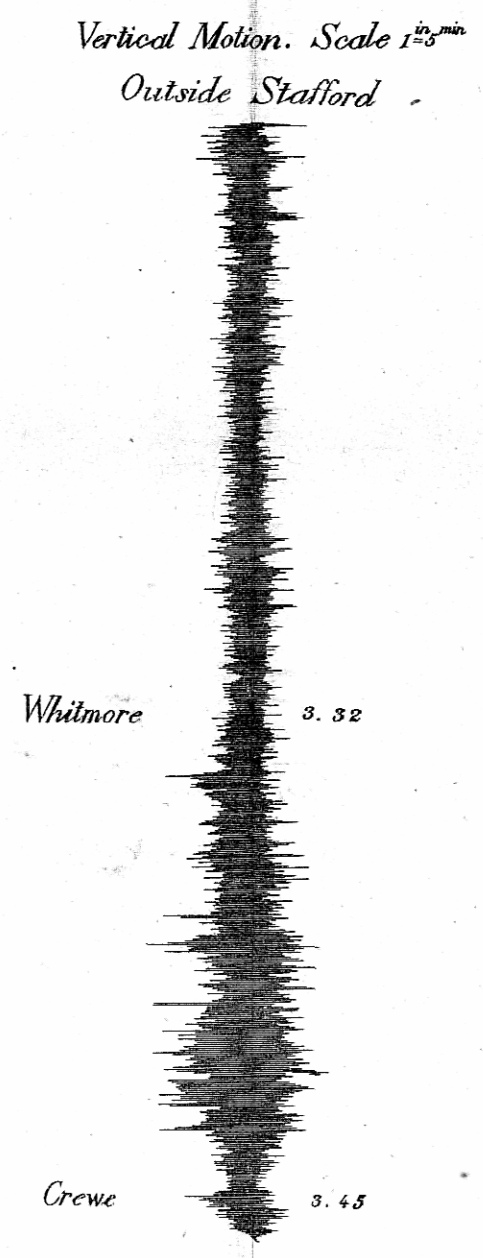
PENNSYLVANIA CENTRAL  
Pullman "New Zealand"  
Scale from 40<sup>th</sup> Street Station  
1<sup>in</sup> = 5<sup>min</sup>



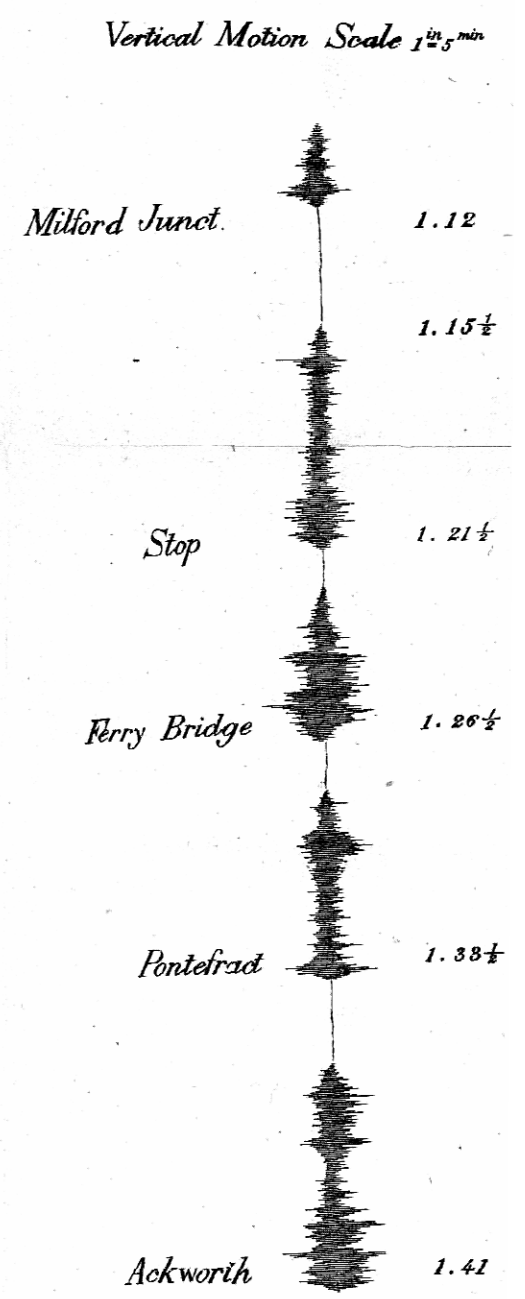
LONDON & NORTH WESTERN RAILWAY  
Second Class



WEST LONDON RAILWAY  
Second Class

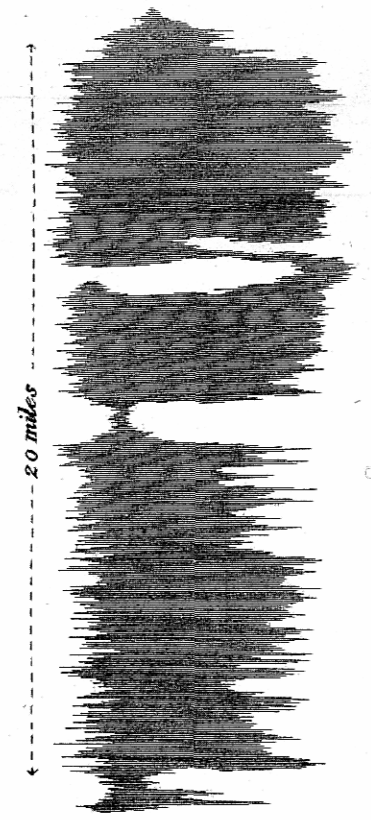


LONDON & NORTH WESTERN  
Third Class

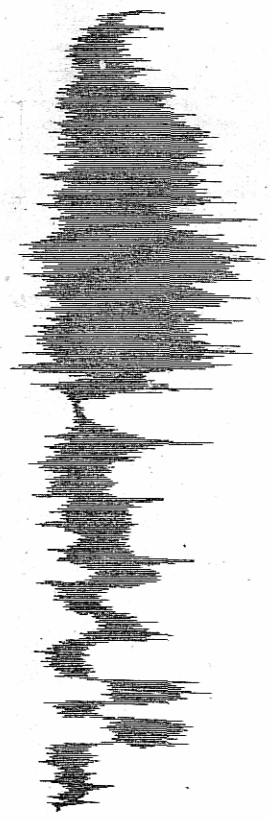


MIDLAND RAILWAY  
Third Class.

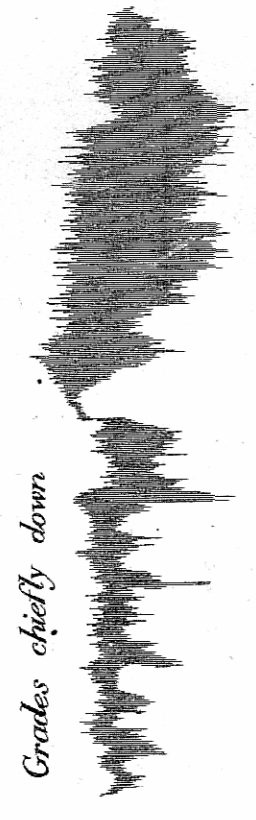
Vertical Motion. Scale  $1 \frac{in}{10 min}$   
Tehachapi



Transverse Motion



Longitudinal Motion



Mojave  
SOUTHERN PACIFIC  
Locomotive 248 C.P.

Longitudinal Motion. Locomotive N<sup>o</sup> 115 Napsyth. Scale  $1 \frac{in}{10 min}$  Speed 28  $\frac{mi}{hr}$



Longitudinal Motion. Locomotive N<sup>o</sup> 84 Dubs. Scale  $1 \frac{in}{10 min}$  Speed 35  $\frac{mi}{hr}$



Transverse Motion. Locomotive N<sup>o</sup> 85 Dubs. Scale  $1 \frac{in}{10 min}$  Speed 35  $\frac{mi}{hr}$

