A Model showing the Motion of an Earth-particle during an Earthquake.

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With Plates XXVI–XXVII.

During an earthquake, seismographs, such as are now used in this country, record the three rectangular components of the successive motions of the ground. These components may then be again compounded to form resultants, which, when joined together, denote the real path pursued by an earth-particle during a prolonged shaking.

The model represented on Plate XXVII was constructed on the above principle to delineate, on a magnified scale, the earthquake motion. It was copied from the diagram (Plate XXVI) of the earthquake* of January 15th of the present year, obtained by Ewing's Horizontal Pendulum and Vertical-motion Seismographs. The waves of the two inner circles in that diagram denote the horizontal components of the earthquake magnified five times while those on the outermost of the three circles record vertical motion enlarged eight times. The plate took two minutes and eight seconds to complete one revolution and the radial lines on it mark the successive

* Japan Earthquake of January 15th, 1887, by S. Sekiya. Vol. I., Part III, of this Journal.

seconds of time from the commencement of the shock up to the seventy-second second.*

In the model the motion-path is represented by means of a copper wire, the course of which was determined by successively compounding the three rectangular components recorded on the earthquake diagram ; numbers marked on small metal plates attached to the wire at different intervals correspond to the number on the radial lines on the diagram. In the actual model the motion is magnified fifty times. To avoid confusion the model was made in three parts each showing the motion for twenty seconds or so; thus, Fig. 1, Plate XXVII indicates the motion from the beginning of the shock to the end of the twentieth second, Fig. 2 from the latter instant to the end of the fortieth second, and Fig. 3 thence to the end of the seventy-second second. They are not traced beyond that point as the vertical motion practically ceases to exist and the movements may be simply represented on a horizontal plane. Each model is firmly mounted on a stand. The figures show the northern aspect of the model, but looking slightly from above.

During these seventy-two seconds, quantitative relations of horizontal and vertical displacements and constantly varying changes in their directions and oscillating periods—in fact everything concerning the movement of the ground—can be studied with ease.

Looking at the model one will observe the complexities and irregularities of the earthquake motion ; at certain moments, the ground moves nearly in straight lines, while in others, it describes somewhat circular or elliptical paths. Similarly the vertical component varies in its range and period and consequently the angles which the motion-path makes with the horizontal plane are constantly changing.

* For more detailed description of these diagrams, see Comparison of Earthquake Diagrams, etc., by S. SEKIYA. Vol. I., Part I, of this Journal.

Before going further it ought to be stated that the origin of this earthquake was in the S.W. in a narrow band of country, seventeen to forty miles from the spot where the recording instrument was placed.

The earthquake begins, as usual, with short-period tremors. During the third second there appears for the first time a vigorous horizontal motion, N.W. and S.E., (that is, at right angles to the line joining the origin of the disturbance and the instrument), accompanied by a considerable vertical displacement. Both horizontal and vertical motions then continue with great activity ; at the ninth second (Fig. I), the upward displacement of 1.3 mm. or $\frac{1}{20}''$ is recorded, which is the largest vertical motion during this shock. Synchronously with it, there occurs the horizontal motion of 5 mm. or $\frac{1}{5}''$ N.W. and S.E., the complete period of oscillation in both being 1.5 seconds. Equally large vertical motion also appears at the tenth second. Vertical motions are most marked during the first part of the disturbance and give to Fig. 1 more striking features than to the other two.

The maximum horizontal displacement of 7.3 mm., or nearly $\frac{1}{4}''$, occurs later on from the thirty-third to thirty-fourth second with the complete period of two seconds. Its direction is then nearly W. S.W. and E.N.E. or nearly in a line with the origin of the shock. There is, however, no prominent vertical motion simultaneous with it.

The directions of the principal horizontal motions in Fig. 3 are S.E. and N.W., or transverse to the direction of the origin of the disturbance, but it would be premature to draw thence any conclusion as to the relations between the directions of the local movements of the ground and the position of the origin, as the seismic waves are influenced in their passage by a great many circumstances.

In the portions of the disturbance exhibited in Fig. 2 only few important up-and-down oscillations occur, as is shown by its

flatter appearance. In Fig. 3, however, several vertical outbursts of considerable amplitude are observed, with inert intervals between. They practically subside beyond the seventy-first second and the disturbances are then entirely confined to the horizontal plane where they continue with great force for more than one minute. Disappearance of the vertical motion long before the horizontal is the usual phenomenon. Also when large vertical motion occurs there is usually to be found simultaneous large horizontal displacement, but the latter often may be recorded without the former.

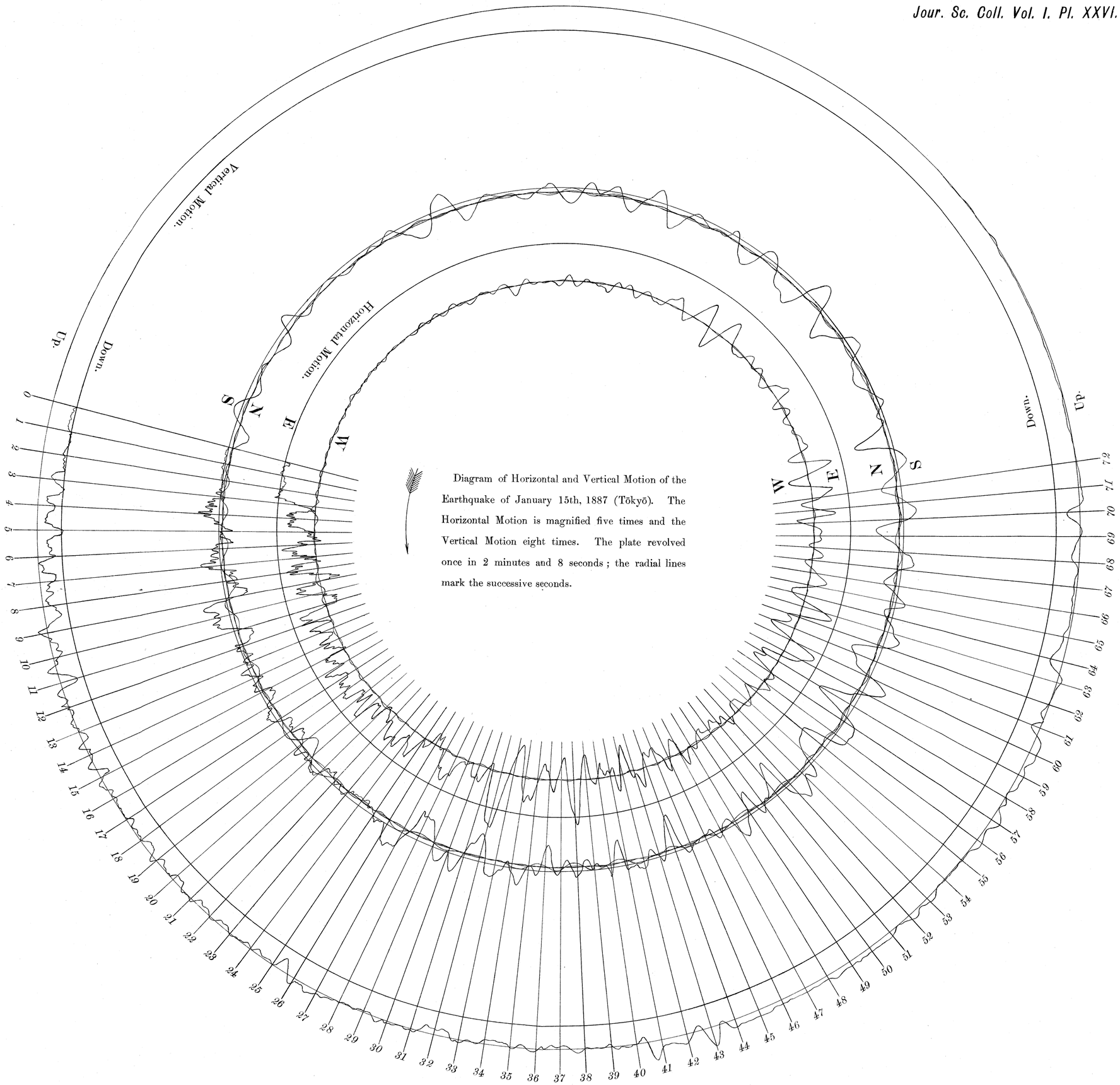

Diagram of Horizontal and Vertical Motion of the Earthquake of January 15th, 1887 (Tōkyō). The Horizontal Motion is magnified five times and the Vertical Motion eight times. The plate revolved once in 2 minutes and 8 seconds; the radial lines mark the successive seconds.

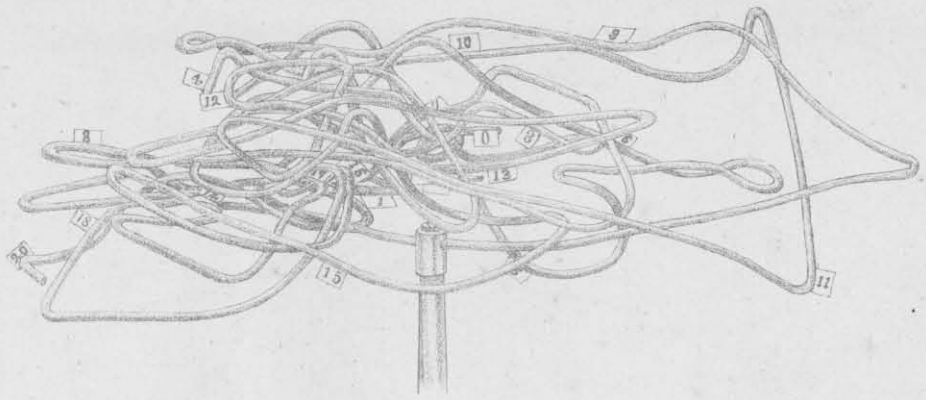

Fig. 1.

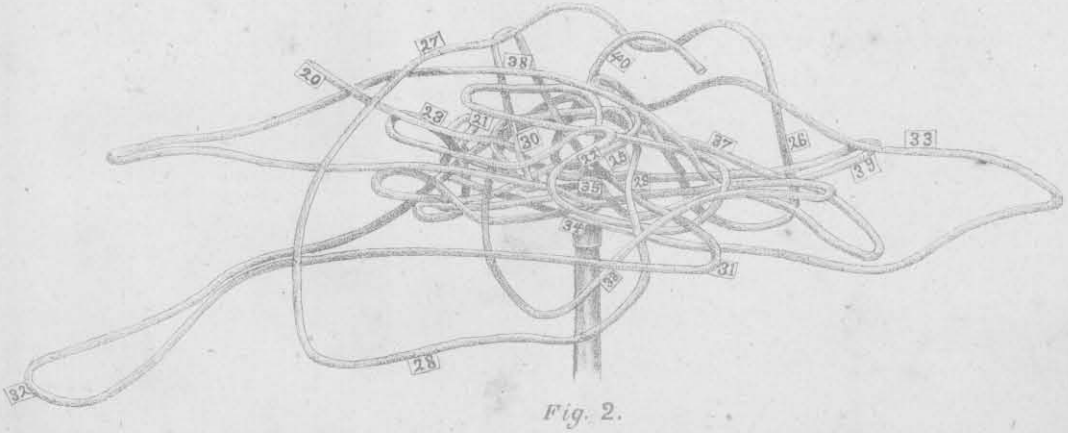

Fig. 2.

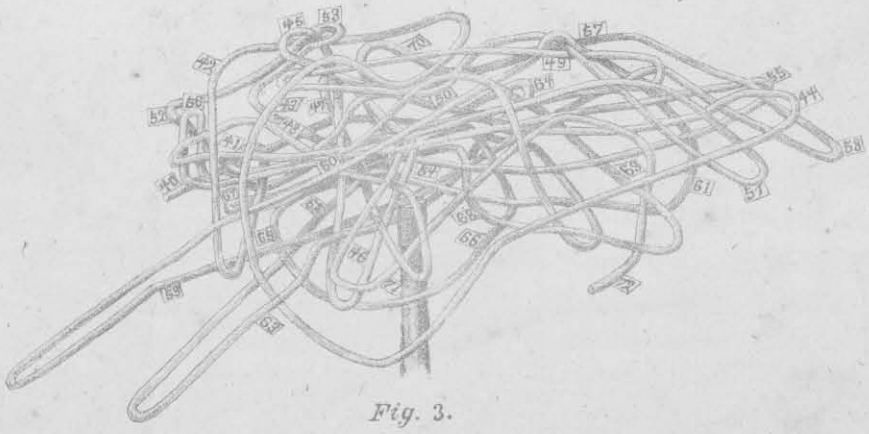

Fig. 3.