NOTE ON PROF. EWING'S DUPLEX PENDULUM SEISMOMETER WITH EARTHQUAKE RECORDS OBTAINED BY IT.

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This is another form of the Duplex Pendulum Seismometer designed by Prof. Ewing just before he left this country in June 1883. Its principle as well as its kinetic condition is the same as that described in the Transactions of this society. Vol. V. The chief object of the form now suggested is to make the instrument more simple and thus fit it for wide use.

Neutral or feebly stable equilibrium, the requisite condiinto for seismometers, is here obtained by combining a common pendulum A which is stable with an inverted unstable pendulum B. The upper or common pendulum is a circular disc of lead and is hung by three silk threads *t* from the top of a wooden tripod frame 3½ ft. high. Three wooden screws *c* at the top allow the length and the level of the pendulum bob to be adjusted. The lower or inverted pendulum is also a circular disc of lead and is supported by a single brass tubular rod whose conical point rests in the agate cup fixed in the wooden base plate. The upper and lower pendulums are connected by a ball and tube joint. A small spherical ball projecting from the upper side of the lower bob accurately but smoothly fits into a vertical tube fixed through the centre of the upper bob. This jointed system has horizontal freedom to move in any azimuth and forms a neutral or feebly stable pendulum whose period of oscillation may be made as slow as we please. A gimbal or universal joint J is carried by the bracket firmly fixed to one leg of the tripod and forms the fulcrum of the indicating pointer. The lower end of the indicating pointer terminates in a ball and easily fits into the before mentioned tube in the upper bob just bove the point where the contact of two pendulums is

made. This point is calculated as the steady point of the system. The upper end of the indicating pointer is a stiff straw with a marking pointer hinged at the top. The end of the marking pointer is furnished with a steel point and rests upon a smoked glass plate on which the earthquake records are to be written. The ratio of the distances from the fulcrum J to the lower and upper ends of the indicating pointer is 1 : 4.4 and therefore the instrument magnifies the motion of the ground 3.4 times. The base plate is furnished with three levelling screws by which the level of the instrument may be adjusted. These screws act as the feet of the instrument and rest in V grooves cut upon the face of a low stone column. The total cost of the instrument is little more than six yen.

This instrument has been set up in the earthquake Laboratory in Tokio Daigaku and has given a number of records some of which we give as examples. Almost all the records obtained indicate the characteristics of earthquake motion. At the first part of the earthquake the pointer oscillates forward and backward nearly in straight lines showing a certain decided direction of motion but gradually it begins to describe loops or sometimes figures of eight. This degeneration of backward and forward motion into loop motion is likely due to the occurence of transverse waves which combined with simultaneous normal waves may produce such results.

Fig. 1. Earthquake Oct. 5th 7.34 A.M. 1884 the diagram indicates the principal movements of the ground to have been in E and W direction with maximum amplitude of 1^{mm}.

Fig. 2. Oct 6th 10. 22. 15 A. M. 1884. The earthquake consisted of series of small movements all in E and W direction, the largest displacement being not more than 0.7^{mm} in amplitude.

Fig. 3. Nov. 23rd 10. 55. A.M. 1884. The diagram indicates motions in all directions but the first movements occurred chiefly in NE and SW. The largest displacement was 2.7^{mm}. These were fol-

FIG 1

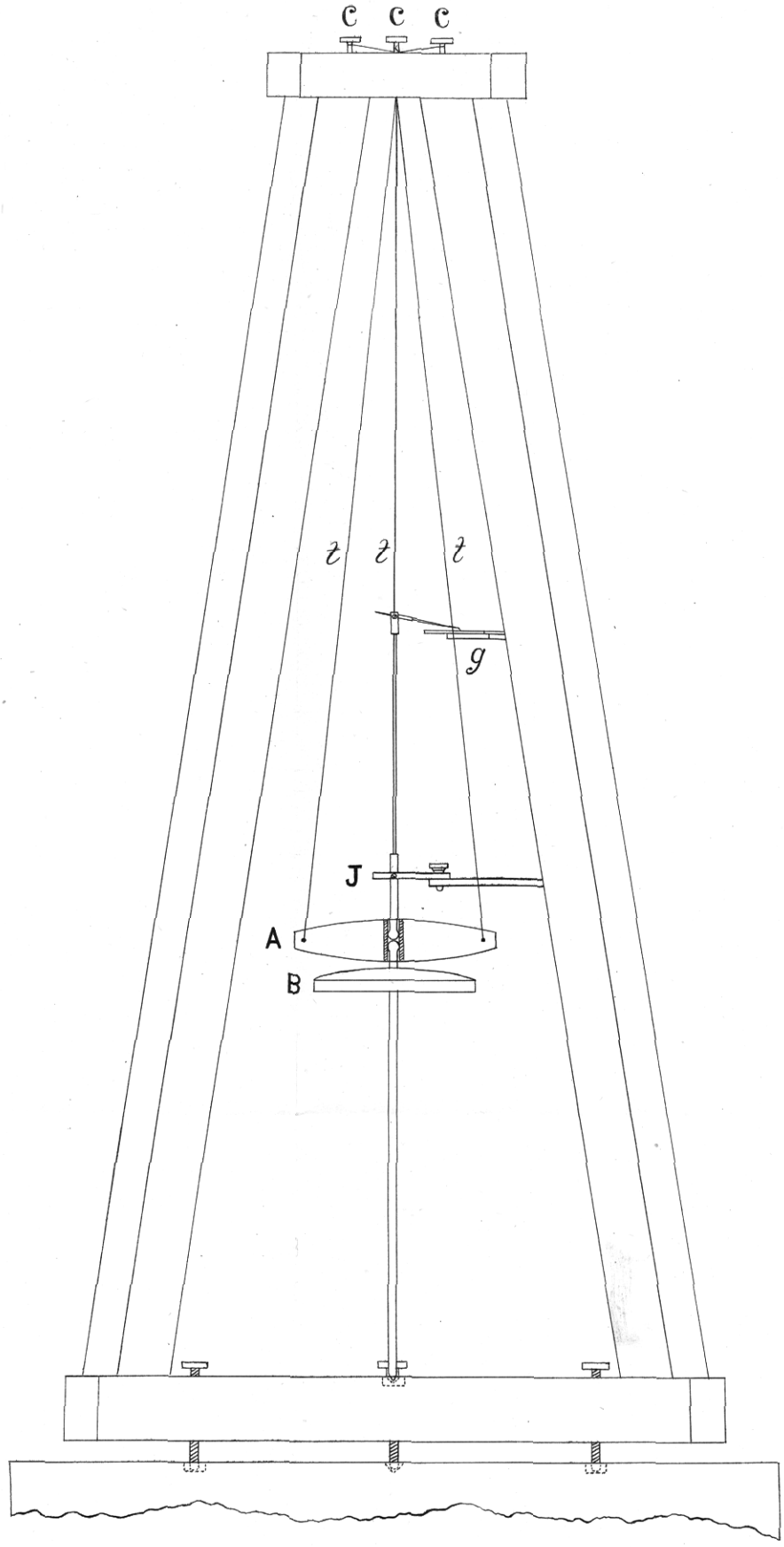
FIG 2

FIG 3

FIG 4

FIG 5

FIG 6



lowed by transverse motions, the combination of which with the former produced the loops and figures of eight.

Fig. 4. Nov. 29th 8. 10. 38 A.M. The direction was dicidedly E and W. The maximum amplitude was 1.5^{mm}.

Fig. 5. Dec. 1st. 8.13 A.M. 1884. The record gives the motions in all directions. The principal movements were however E and W while they were intersected in transverse directions by many disturbances. The maximum motion appears to be 2.6^{mm}.

Fig. 6. Jan. 3rd 2.52 A.M. 1885. At the beginning of the earthquake the direction of motion was chiefly NW and SE, but the largest motion was transverse to this in NE and SW, the maximum amplitude being 2^{mm}.

These records when compared with those obtained on a revolving glass plate by a more elaborate instrument agree very well in their main features.