13. *A Portable Horizontal Pendulum Seismometer.*

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After the eruption of the Volcano Usu, Hokkaidô, in 1910, late Prof. Omori set up a portable seismometer which he had constructed, near the volcano to record earthquakes of volcanic origin. Since then after some great earthquakes, portable seismometers are costumarily set in the seismic area to observe after-shocks by members of the Seismological Institute and the Earthquake Research Institute of the Tokyo Imperial University. And seismometrical trianguration and other noteworthy studies were made with seismometers like above mentioned, after the great Tango earthquake of 1927[1] and the Idu earthquake of 1930.

The writer made a new portable seismometer lighter than those which have been made before, and it may be easily carried by a motor-car or two men on foot.

The Portable Horizontal Pendulum Seismometer.

In the first place, the writer decided that for registering earthquakes mechanical method is applied to the seismometer, because optical method is unhandy in field work. Some merits in mechanical registering are that seismograms are seen directly and no need of dark room, electric cells. But petroleum to smoke recording papers and vanish to fix soot on the paper are ought to be carried with the instrument when it registers mechanically, and these are very troublesome to transport.

The recording drum is a hollow aluminium cylinder 25·5 cm. long, 18 cm. in diameter and its rotation axle 52 cm. long. Recording point displaces 0·75 mm. sideways after a revolution which takes ten minutes. In other words, the velocity of index is about 5·6 cm. per min. on the smoked paper.

1) N. NASU, "A stereometrical study of the aftershocks of the great Tango earthquake," *Journ. Fac. Sci., Tôkyô Imp. Univ.*, Sect. II, 3 (1929), 29.
In this paper, descriptions on the Imamura Portable Seismometer are given.

On a chlumin—a light aluminium alloy invented by Dr. Iidaka—plate, two horizontal pendulums are set up to record two components of horizontal motion of earthquake separately. The pendulum is consisted of a brass framework which suspends a lead cylindrical bob with two steel ribbons. The steel ribbons are used, because they are strong and seldom broken in transit. The bob is 5 kg. in weight, and fixed in the framework with two screws at its top and bottom. It is taken off from the frame when the seismometer in transportation. The framework stands with three screws on the bed-plate, and the period of self-vibration may be changed by adjustment of levelling-screw. The seismometer has been operated successfully when the period is between 3·5 and 5 sec., and the recording magnification is usually set forty. Then instrumental constants at some time, are shown as follows.

$$V=40,\ T_0=3{\cdot}79,\ \varepsilon=0{\cdot}144,\ r/T_0^2=0{\cdot}122.$$

The instrument is not equipped with damper, for damping of the pendulum is somewhat sufficient in this case. But the writer intends to put a damper on the pendulum. Time signals are made by lifting of the recording index with a electromagnet, which is operated once a minute by a clock.

The seismometer at transportation is packed in a box covering the bed-plate with a steel lid 54 cm. long, 38 cm. wide and 25 cm. high, after the two bobs are taken off and the frameworks are clamped on the plate. The weight of the above-mentioned part is 18·5 kg. After removed from the frame, the two bobs are put in another box with the clock-work which drives the recording drum, and the latter box weighs 17 kg in all. When the seismometer is set at places where electric power supplied all day, a simple synchronous motor designed by the writer is used in place of the clock-work as shown in figures on Pl. XIV. Details of the motor will be described below.

A Synchronous Motor for Driving the Recording Drum.

The rotor of the motor is a circular disc, axle of which is supported with two ball-bearings. Twenty small and short circular iron rods are inserted in equal distance near the edge of disc. The rods pass through between two poles of the electromagnet when the disc rotates around its axle. The coil of the electromagnet is charged with alternating current of frequency fifty per sec. So when the disc made revolve at the rate of five turns per second, rotation of the rotor synchronize with the variation of the magnetic force. Then the motor continues its rotation in

a uniform speed. But its velocity is too fast for the recording drum, so the rotation of the drum is made slow by means of worm-gears to the rate of one revolution in ten minutes. It is inconvenient that the motor comes to a halt with the shutting off the current, and it does not turn automatically when current supplied again. So in some cases, another self-operating synchronous motors of the like construction are in use.

Remarks.

The seismometer and the synchronous motor are both made to be portable and easy to handle. Moreover the writer wishes these instruments serve to seismic observations made by anyone who has interest to earthquake. And when some improvements are made, it may be of use even at seismological stations as an auxiliary instrument. The several instruments of the type here stated were already used to record the after shocks of the *Daisyôzi* earthquake which occurred in *Kaga* Province on Oct. 17, 1930[2], the *Idu* earthquake of Nov. 26, 1930 and the *Saitama* earthquake of Sept. 21, 1931.

In conclusion, the writer desires to express his most cordinal thanks to Proffesor M. Ishimoto for his kind advices and supervision.

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13. 携帯用水平動地震計

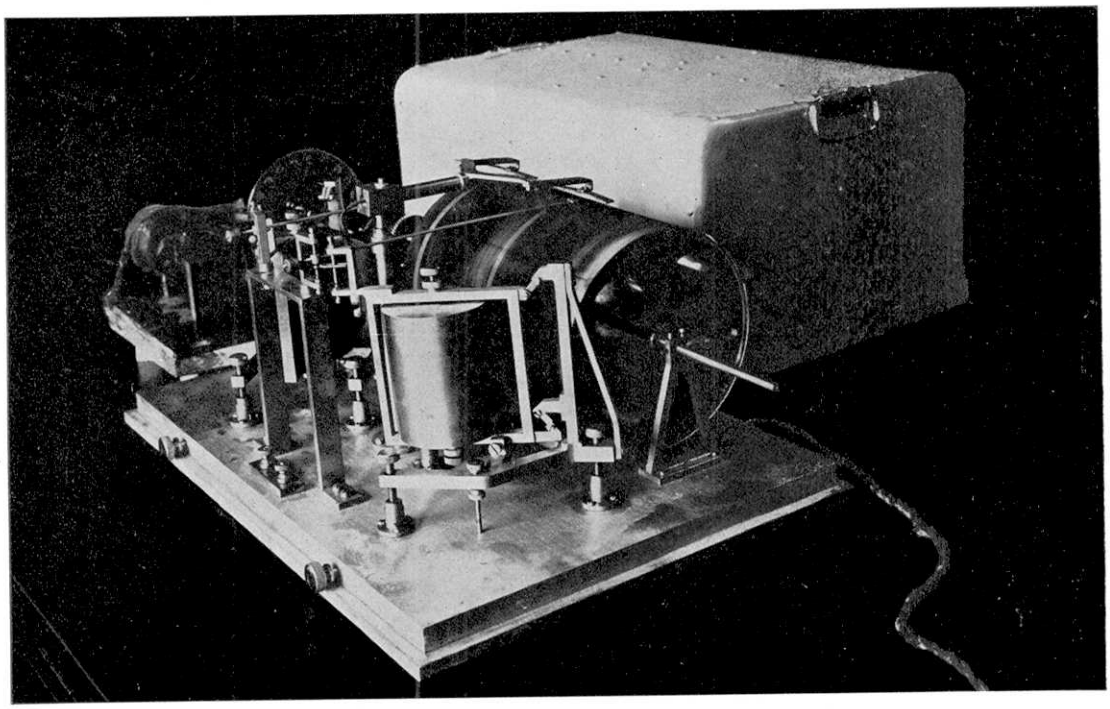
岸 上 冬 彦

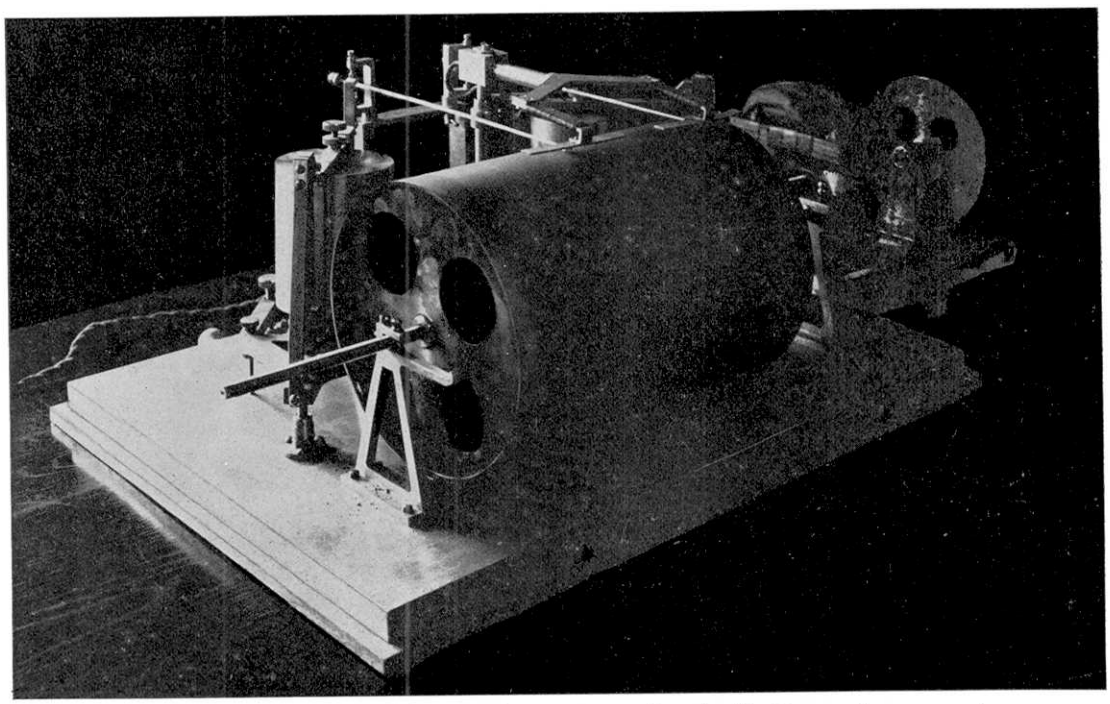
大地震の後で餘震調査の爲に屢〻携帯用地震計が地震のあつた地方に据えられるが、筆者は從來のものより輕くて取扱の簡單なものをつくつた。未だ完全なものではないが、此處に簡單に其の器械について報告する。

携帯用地震計には記錄裝置は光學的にするよりも煤紙の上に機械的にした方が適當と考へた。次に記錄用の回轉圓筒の大さを決め、其の大さは長さ 25·5 cm. 直徑 18 cm で、回轉の軸の全長は 52 cm とした。回轉の速さは 10 分間に 1 回轉にして、其故記錄用の針は 1 分間に約 5·6 cm 圓筒上を進むることなる。

地震計は二つの水平振子から成立ち、水平動を二つの方向に分けて記錄する。振子の重錘は 5 kg の鉛で、二枚の鋼の薄板で吊るされてゐる。鋼の板を用ひたのは其が運搬中に毀れ難いからであつて、重錘は運ぶ時は取外して、記錄用圓筒を廻はす時計仕掛と一緒に一つの箱に入れる。地震計は三菱造船研究所の飯高博士の發明されたクルミンといふ輕い合金で造られた臺の上に載つてゐて、運搬するときは、夫に鋼鐵製の蓋をして長さ 54 cm. 幅 38 cm. 高さ 25 cm. の箱とする。此の重

2) F. KISHINOUYE, "Report of the strong earthquake of the southwestern part of Kaga Province, Oct. 17, 1930," *Bull. Earthq. Res. Inst.*, 9 (1931), 216.





The Portable Horizontal Pendulum Seismometer equipped with the synchronous motor.

量が 18·5 kg. で、前記の重錘と時計仕掛の重量が 17 kg. である。自動車、サイドカー付の自動自轉車によれば容易に持運ばれ、又場合によつては二人で分けて運び得る位のものである。

記錄用圓筒を廻轉させるには通常は時計仕掛を用ひるが、終日送電されてゐる所では次に述べる同期電動機を用ひる方が良い結果が得られる。圓板に鐵の鋲を 20 嵌入して、その鋲を週波數 50 の交流を通じた電磁石の極の間を通過する樣にして圓板を廻はしてやる。圓板の回轉が 1 秒に 5 回になると、交流によつて生ずる磁力變化と回轉とが共鳴作用を起し、圓板は一樣に回轉を繼續する。記錄するには此の儘の速度では速すぎるのでウォーム、ギヤアで記錄用圓筒は 10 分間に 1 回轉する樣にする。以上の樣な電動機は停電があると、假令電流が再び來ても 回はり 始めないのが缺點である。併し、同樣な原理で自動的に回轉を開始する一層精巧なものも用ひられてゐる。

此等の器械は携帶用計りでなく、地震に興味を持つてゐる人は誰でも觀測が出來る樣にしたつもりで製作されたものである。併し又少し手をかければ、觀測所に置く器械としても用ひられるであらうと思ふ。今迄には大聖寺地震、伊豆地震、埼玉地震の餘震觀測等に用ひられた。