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69. *The Submarine Seismograph, the Second Paper.*

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Seismic observations on the ocean bottom are now an urgent demand in geophysics. After the writer published his first paper on the submarine seismograph, he was supported by the Special Research Fund, the Department of Education, for the study on the seismograph. So he changed his project to construct his ideal submarine seismograph, and invented instruments of two types for trial. A brief report of these results is written hereunder.

The Submarine Seismograph II

The first seismograph recorded only vertical motions of the sea bottom. The second one was installed as in the case of the first one, however, three components of earth motions could be recorded with it.

A four-channel electromagnetic oscillograph was set in the case. Three of the channels were put on for three components, i.e. two horizontal components and one vertical component of earth motions. Galvanometers in the four channels were equally 0.01 sec. the selfvibration period, and the period of transducers of the three components 0.1 sec. Each transducer was connected with a transistor amplifier, and ranges of recording amplitude and period were widened. The remaining one channel was used for a timer which marked on the record every 1 minute, 1 hour and 12 hours. The four channels were recorded on a roll of 16 mm cine-film of film-speed ASA 400 about 120 m long. The recording velocity was 8 mm/min., so the recording was effective for as long as two weeks continuously. A small electric lamp through a tiny point opening was used as the light source of the recording, similarly as described in the first paper. (Fig. 1) A test observation was carried our at Misaki, the same place as the previous time, a portion of the record being shown in Fig. 2.

The submarine Seismograph III

The project was advanced by the writer to record long-period earth motions such as microseisms, earthquake waves propagated on the ocean bottom, and others. Then the transducers of 1 sec. period were installed

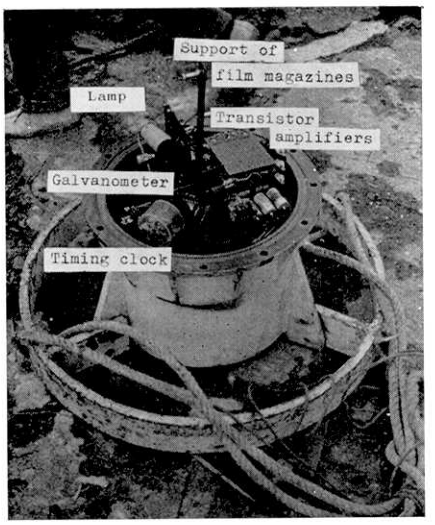

Fig. 1. Seismograph II.

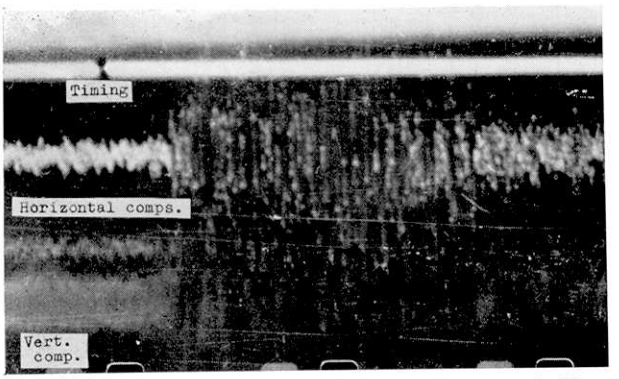

Fig. 2. A Portion of record from seismograph II.

in the case of the seismograph. Two of these were for horizontal motions of sea bottom and one for vertical, each component being connected with a transistor circuit similarly as seismograph II.

The transducers of long self-vibration period were influenced by the inclination of their installed position. Then an automatic levelling device was invented to set the transducers on a horizontal plane (Fig. 3). The three transducers were fixed on a circular base plate. The plate was supported at its centre with a semi-spherical cavity on the lower surface. The cavity was put on a spherical ball, 3 cm. in diameter, which stood on the base of the seismograph case (Fig. 4). When the seismograph

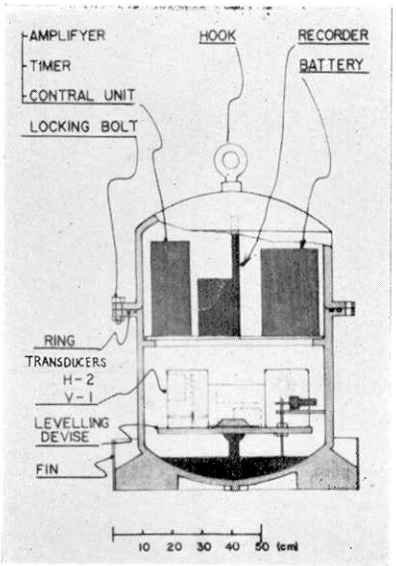

Fig. 3. Seismograph III.

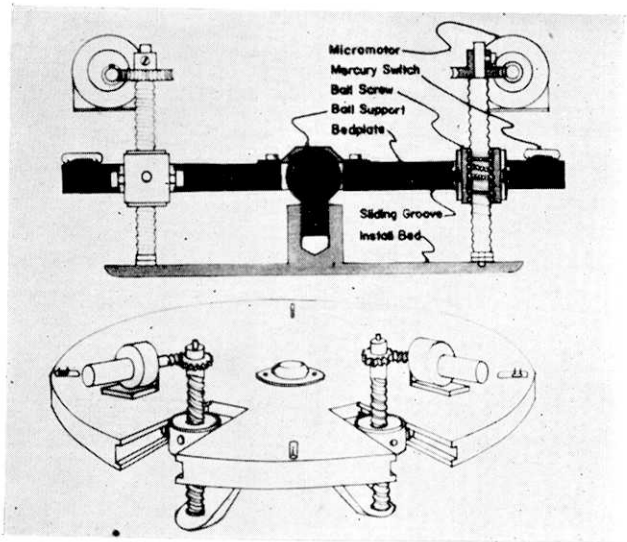

Fig. 4. Automatic levelling device.

submerged on the sea bottom and the bed plate were not horizontal, two mercury switch as of three poles operated as levels and closed circuits of micro-motors. Then the motors began a rotation of axes of ball-screws till the bed plate became horizontal, and stopped their action when the switch opened the circuit. The range of the levelling device

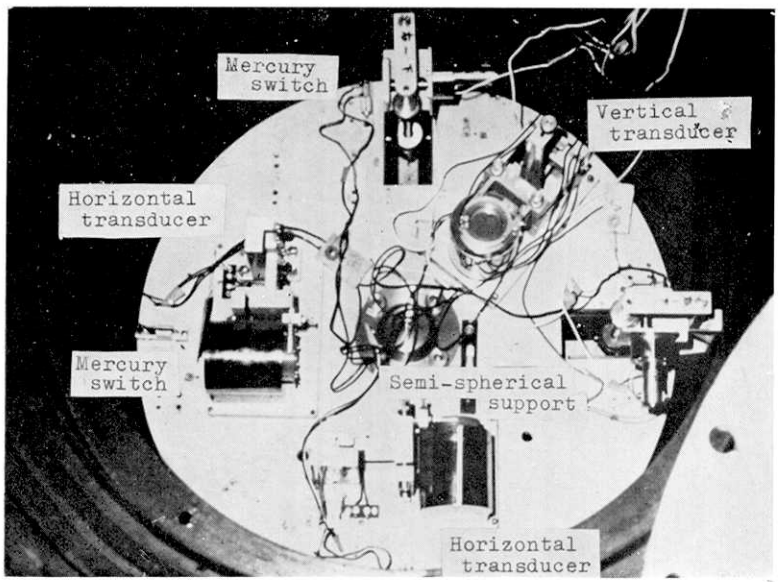

Fig. 5. Transducers on the automatic levelling plate.

was about $\pm 15°$.

A 6 V secondary battery was fixed on the bottom of the case. It served for four micro-motors and an electric lamp. The electric supply was mostly used for driving of recording film and lamp, the electric currents for automatic levelling and floating equipment being negligible because the current supply was short in time.

The timing marks were made by short breaks of record lines with an electric clock. Electricity for timing was supplied by a small 1.5 V dry cell.

Azimuths of the two horizontal components during the recording on the sea bed were reserved with a common pocketable magnetic needle modified for the purpose. The pivot and the needle circle of the magnetic needle were surrounded with aluminium rings in small gaps. When the seismograph was submerged, the vessel of the magnetic needle was filled with fresh water. The water was replaced with sea water at the bottom, and the aluminium rings were corroded chemically by the sea water. The rings later swelled by corrosion and stopped the movement of the needle, and the azimuth of the horizontal transducers on the sea bottom would be indicated on the stopped needle.

The case of the seismograph III was more enlarged than that of seismographs I and II, the inner volume of the case 340 l., the weight

in the air 505 kg. and in water 260 kg, and when transducers, recorder and others were placed in the case the weight became about 600 kg. in the air.

The seismograph on the sea bottom was connected with the floating tank, concrete blocks and radio-buoy. These parts were connected with nylon wires, nylon being light in weight and strong in sea water. After the scheduled recording was finished, the timing switch made the concrete blocks disconnect from the floating tank filled with gasoline. Then throwing the concrete blocks away, the seismograph rose to the sea surface with tank and the radio-bouy, the buoy sending radio-waves in air to transmit the position of the floating seismograph.

At the conclusion of this paper, the writer expresses his thanks to Mr. Yoshio Yamazaki for his concise help in the study of seismograph II. He also thanks Mr. Heihachiro Kobayashi and Mr. Sadayuki Koresawa for their assistance in the construction of seismograph III.

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69. 海 底 地 震 計 (第2報)

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本彙報第41号に報告した海底地震計を第1号とし，これは上下動のみであつた．第2号には水平2成分を加え3成分の記録を16 mmのフィルム上に時刻の合図とともにのせ，約2週間の連続観測ができるようにした．

さらに第3号では周期の長い換振器を装置するために，海底において自動的に水平になる台を考案し，台の傾斜のため振子の感度が変わらないようにした．