48. *On Microseisms of Four Second Period.* *(The Second Paper).*

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(Read May 21, 1935.—Received June 20, 1935.)

1. In a paper in this journal[1] the writer has described some results of observation of microseisms at Hongô in Tôkyô, periods of which are about 4 sec. But in that case records of only N–S component motions were investigated. Then microseisms were studied further by combining three components of the motions.

Seismographs record oscillations with some time-lag which depends upon period and damping of seismographs and period of oscillations. So when resulting motions are obtained by combining components recorded with different types of seismographs, phase differences of the component motions have to be noticed. Then the writer measured constants of many seismographs which were available, and selected following instruments shown in Table I for the investigation because he found that phase differences for microseisms of 4 sec period were least for them.

Table I.

Instrument	Component	M	V	T_0	v	r	δ
Omori horiz. pend. seismograph	E–W	17 kg	15	58·4 s	1·27	0·43	171°
Ditto	N–S	42	20	49·6	1·71	0·15	161
Omori vertical seismograph	U–D	15	20	11·0	1·04	0·20	178

In the above table, M denotes the weight of the pendulum-bob, V the static magnification, T_0 the free period of the seismograph, v the damping ratio, r the coefficient of friction and δ the phase lag for harmonic disturbances with period of 4 sec. The phase difference was somewhat great between N–S and U–D component seismographs and amounted to 17° in angle or about 0·2 sec in time. It was neglected in the combination of components, for it may be not so great as compared with other errors of the observation.

1) F. KISHINOUYE, *Bull. Earthq. Res. Inst.*, **13** (1935), 146∼154.

2. Microseisms were large in amplitudes on Jan. 1∼2, 1935. Then simultaneous portions of records of the oscillations obtained with the seismegraphs shown in Table I at about 11 h 30 m on Jan. 1 were taken for the investigation. They were enlarged photographically as large as 1 minute interval of the records became 180 mm. (Minute marks on records of the three seismographs were put on simultaneously with one chronometer.) Amplitudes were read at intervals of 1 mm on the enlarged records, and then divided by dynamic magnifications of the instruments. Fig. 1 shows true earth movements obtained by the above-stated means.

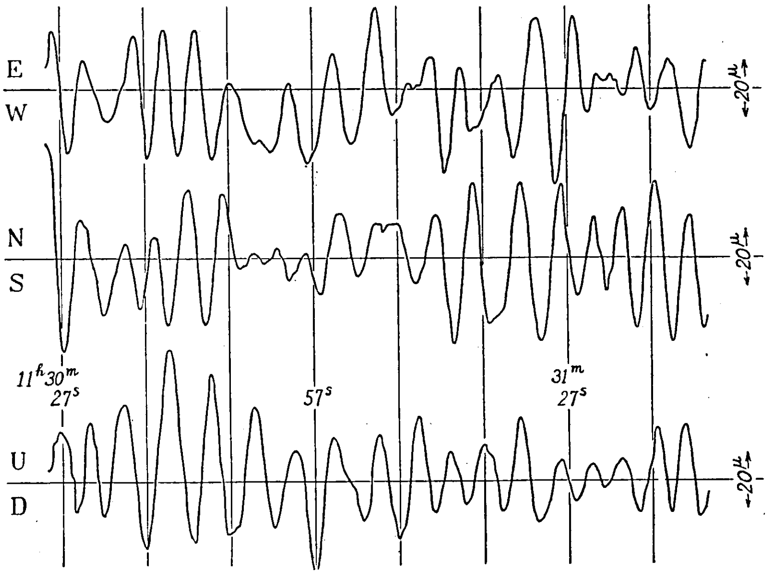


Fig. 1. Portion of record of microseisms. Jan. 1, 1935.

Amplitudes of each component vary like beats of two harmonic motions, and periods of the beats fluctuate between 30 sec and 50 sec. Although periods of the oscillations are nearly equal in each component, phases are different with each component. Azimuths of composed motion of E–W and N–S components and orbits of horizontal motion of an earth particle change incessantly as shown in Fig. 2. This fact has been noticed by Omori[2] and Wadati[3]. The writer moreover combined vertical and horizontal components, and the results are shown in Figs. 3 and 4. These diagrams resemble those in Fig. 2.

2) F. Omori, *Bull. Earthq. Inv. Comm.*, **5** (1911), 136.
3) K. Wadati, *Jour. Meteorol. Soc., Japan*, **4** (1926), 83∼86.

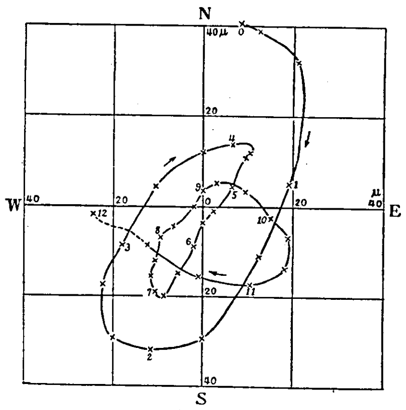
3. The orbits of an earth particle were different from those in precessional motion. When amplitudes became small, the azimuth of the motion changed nearly perpendicular to the previous azimuth, and the direction of the rotational motion of the particle also changed opposite to that in the previous azimuth. The change of directions of rotational motion at the least amplitudes may confirm the writer's idea that microseisms of 4 sec period at Hongô are composed of two harmonic oscillations, period and amplitude of them are slightly different, for in theory the amplitude of the resultant motion of such motions varies like beats and the phase changes as much as 180° at the smallest amplitudes as stated by Thompson[4]. Then if u, v, and w denote E–W, N–S and U–D components of microseisms respectively, they may be expressed as follows:

$$u=u_1\sin(p_1t+\delta_1)+u_2\sin(p_1t+\delta_2),$$
$$v=v_1\sin(p_3t+\delta_3)+v_2\sin(p_4t+\delta_4),$$
$$w=w_1\sin(p_5t+\delta_5)+w_2\sin(p_6t+\delta_6).$$

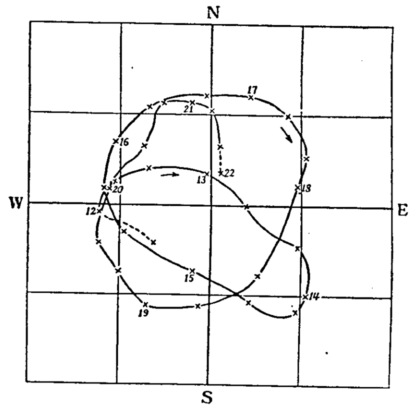
Relations between amplitudes $u_1, v_1, \cdots w_2$, periods $p_1, p_2, \cdots p_6$, and phase differences $\delta_1, \delta_2, \cdots \delta_6$ may be determined if the nature of microseisms is made clear. The writer considers with his present knowledge that $p_1=p_3=p_5=p$ (say), $p_2=p_4=p_6=p'$ (say) and $\frac{2\pi}{p}$ and $\frac{2\pi}{p'}$ are nearly equal to 4 sec. Assuming $\delta_1=\delta_3$ (this assumption may not lose generality of the discussion), δ_2 may be nearly equals to $\delta_4+\pi$ by a formula in Thompson's paper.

4. Many investigators have endeavoured to explain how microseisms are generated. Gutenberg[5] and Lee[6] considered that microseisms consist of Rayleigh waves. On the other hand, many Japanese seismologists are of opinion that microseisms are free oscillations of the ground. The above mathematical expressions may denote the motion of particle which is caused by either progressive or stationary waves, and at present there is no data to determine the character of the waves. But according to the results obtained, the writer inclines to consider that microseisms of 4 sec period at Hongô are stationary waves of the ground generated by some origin.

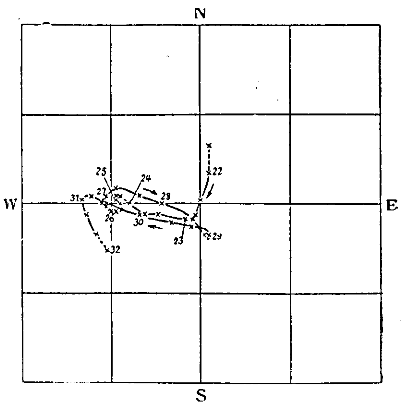
4) J. S. THOMPSON, *Phil. Mag.*, **15** (1933), 1~15.
5) B. GUTENBERG, *Bull. Seism. Soc., Amer.*, **21** (1931), 1~24.
6) A. W. LEE, *M. N. R. A. S. Geophys. Suppl.*, **3** (1932), 83~105; *Ditto*, **3** (1934), 238~252 and *Geophys. Mem. Meteorol. Off.*, No. **62** (1934).



(Fig. 2a.)



(Fig. 2b.)



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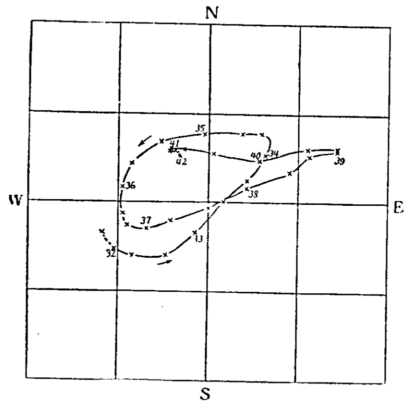

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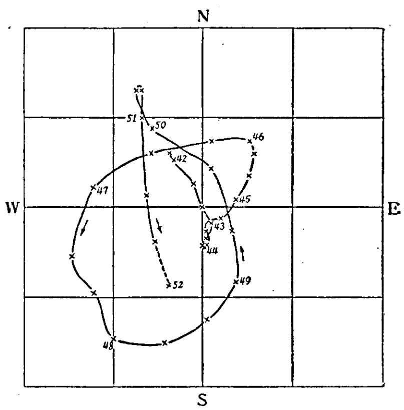

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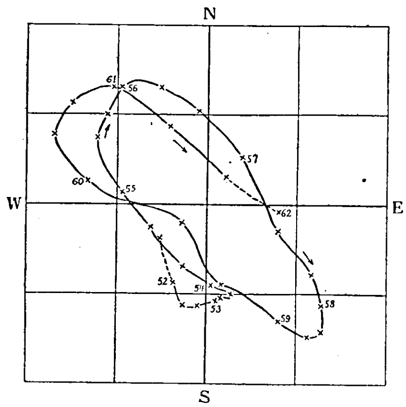

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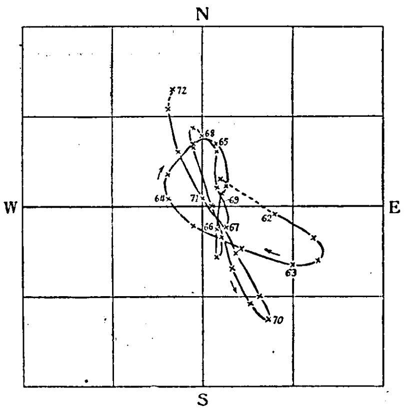

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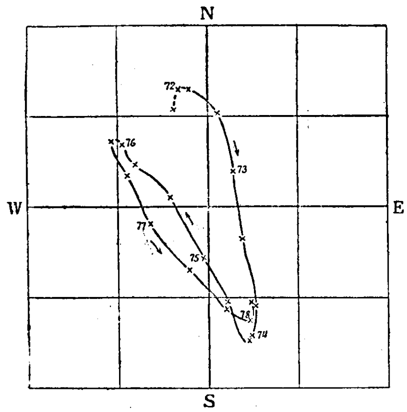
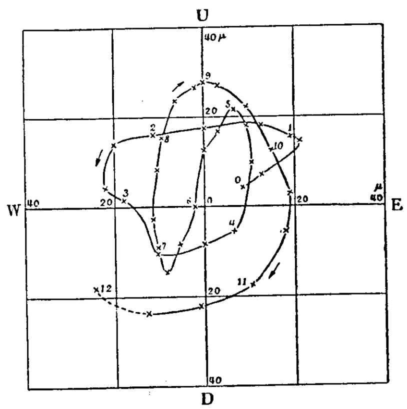
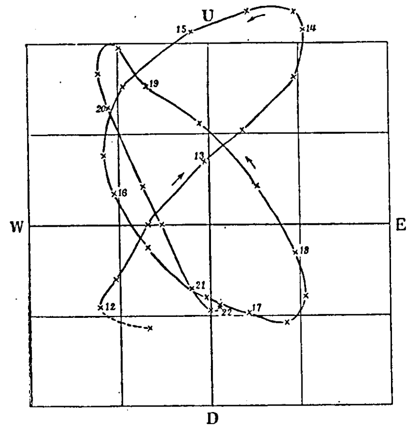


(Fig. 2h.)

Fig. 2. Ground movement in horizontal plane.
Italic numerals indicate time in second, and arrows direction of motion of an earth particle.



(Fig. 3a.)



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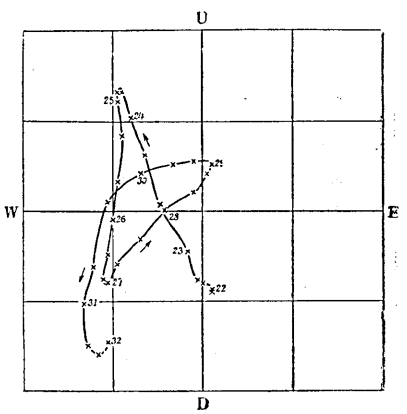

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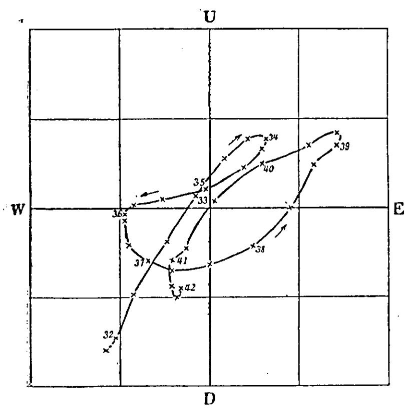

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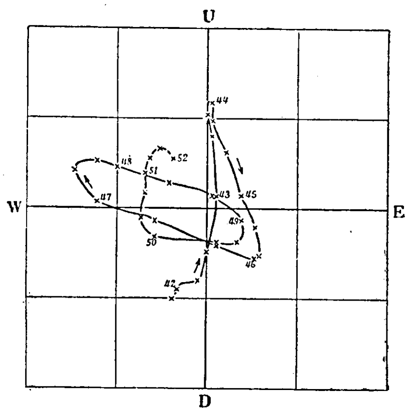

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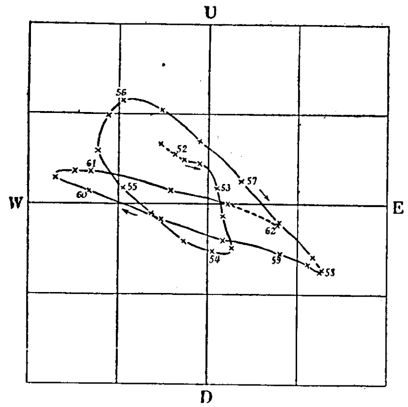

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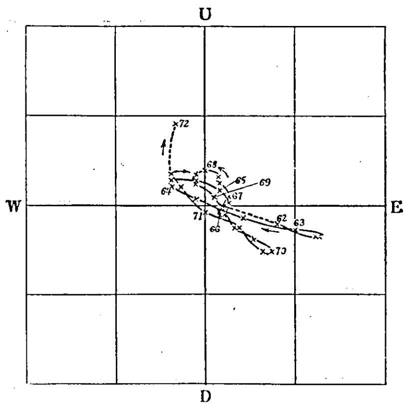
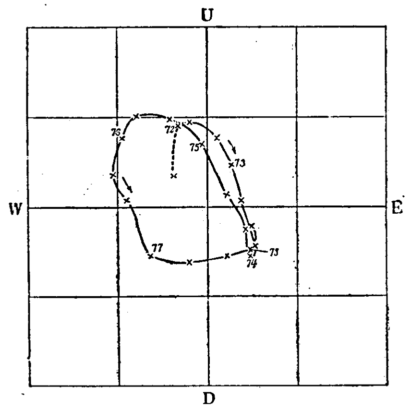
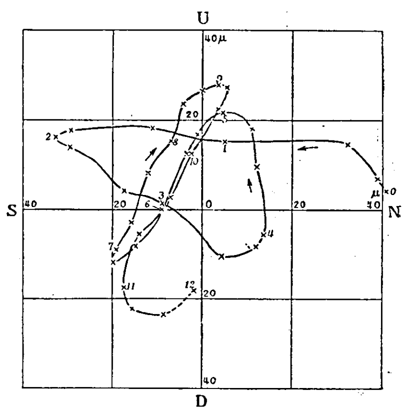


(Fig. 3g.)

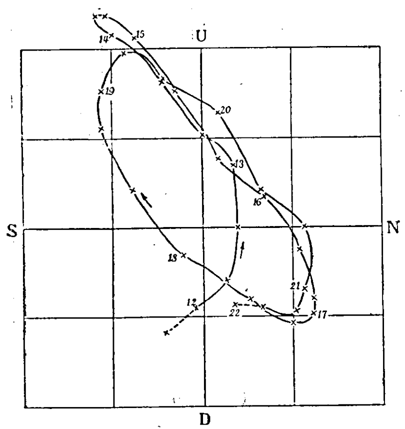


(Fig 3h.)

Fig. 3. Ground movement in meridional plane.



(Fig. 4a.)



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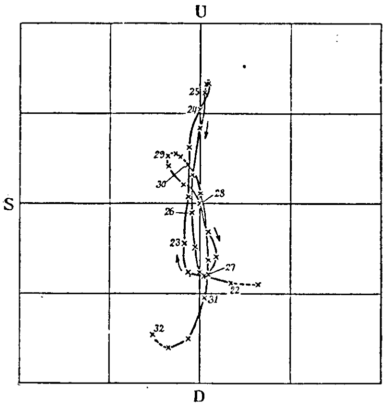

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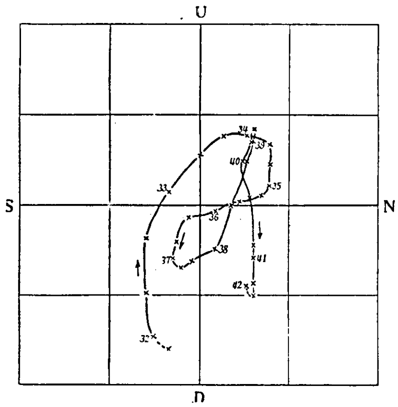
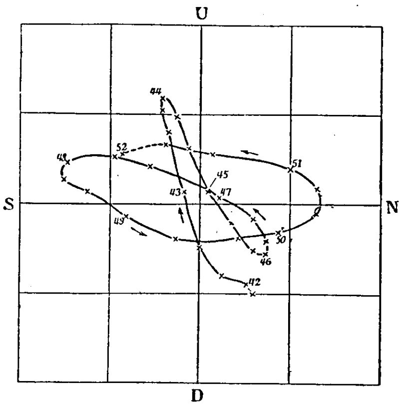


(Fig. 4d.)



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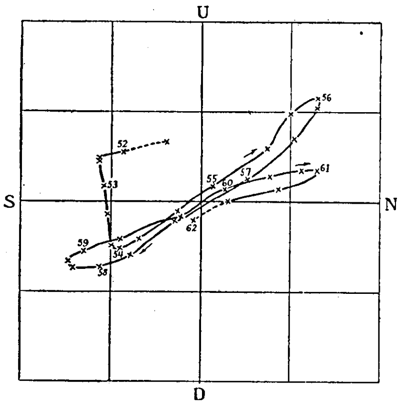

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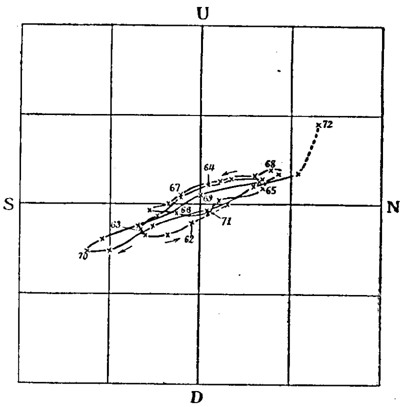
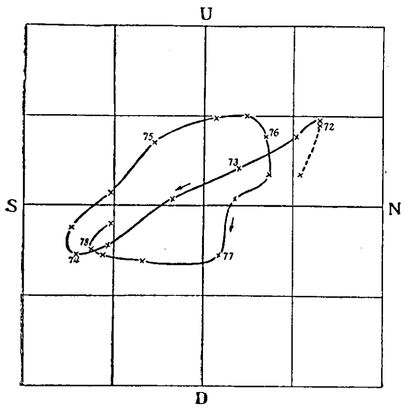


(Fig. 4g.)



(Fig. 4h.)

Fig. 4. Ground movement in prime vertical plane.

48. 週期4秒の脈動(其の2)

地震學教室 岸上冬彥

前に本號 146~154 頁に述べた東京本郷に於ける週期4秒の脈動の研究では南北動の記象だけを用ひたので，其の不足を補ふ爲に此處に東西動及び上下動を含めて測つた結果を報告する．地震記象は地動に對して位相の遲れがあるので先づ其の差の少い地震計を選んだ．調査に用ひた三成分の器械は大森博士の製られたもので其の常數は第I表に示された通りである．昭和10年1月1日11時30分頃の振幅の大きい脈動の記象をとつて各成分を組合せた圖を描いた．水平動は既に大森博士•和達博士の云はれてゐる樣に振動の方位が變化する．其と共に廻轉の向も變はることが示された．此ことは二つの週期振幅共に近い値をもつた振動を組合せて出來る唸によく似てゐる．上下動と他の成分と組合せた圖を見ても振動の形の變化が似てゐるので，筆者は前に得た結果も考へに入れて本郷の週期4秒の脈動は二つの互によく似た振動を組合せたものと考へ度い．