tigation of Tôhoku District[5], it may be said that the depth of the Mohorovičić discontinuity in the north-eastern Honsyû is about 20–30 km. This result was also obtained by one of the writers few years ago from the observed travel time curves of shallow earthquakes[6].

The fact that earthquakes near Tukuba occur deeper than 30 km is well-known to Japanese seismologists. Combining this fact and the crustal structure obtained above, it may be said that at least in the northern part of Kwantô District almost all the earthquakes occur below the Mohorovičić discontinuity. Thus, a clear correspondence between the crustal structure and the position of earthquake foci is established in Japan for the first time.

In deriving these models, members of our Research Group for Explosion Seismology joined in our discussions and gave us valuable suggestions for which our sincere thanks are due.

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19. 大爆破による北関東地方の地殻構造について 其の 2 地下構造

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嶋 悦 三*** 玉城逸夫****
淺野周三*** 淺田 敏***
松沢武雄***

其の1 のよみとり結果を使つて関東北部の東西断面における地下構造を求めた．

結果は Fig. 8a, b, c の通りで，全部でモデルを 5 つ作つた．そのうちモデル I を当グループとして採用することにした．それが最も簡単であり，かつ走時の観測値から計算値を引いた値が全体として小さく，したがつて最もよく走時の観測値を説明できるからである．

モデル II, III はモデル I の Moho 面下の P 波の速さを 8.1 km/sec とした場合，走時の観測値がどの位よく説明できるかを試すために作られた．

モデル IV は Moho 面下の P 波の速度を 7.5 km/sec とし，かつモデル I の 2.7 km/sec 層が地表到る所るあると仮定して試みたものである．

モデル V は，先に東北地方における爆破観測で得られた 5.8 km/sec, および 6.2 km/sec 層を仮定し，これで，どの程度まで走時の観測値が説明できるかを試すために作られた．

Fig. 8 および Table 7 の結果から分るように，Moho 面下の P 波の速度を 7.5～8.1 km/sec の間で変化させても，Moho 面までの深さはやく 25 km になる．これは従来考えられていた 50 km という考えを，大巾に修正するものである．

5) The Research Group for Explosion Seismology, *loc. cit.*, 1).

6) I. TAMAKI, *Zisin*, [ii], **7** (1954) 1, 226.

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20. *Self-levelling Vibrograph.*

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Earthquake Research Institute.

(Read Jan. 24, 1956.—Received June 30, 1958.)

1. Introduction

A transducer of the pendulum type having a natural period of over about 0.2 sec is necessary to keep the supporting bed of the pendulum level. Vibrographs of the usual type can scarcely be operated at such special places as a bored hole, the bottom of a river or the sea, the upper part of tall chimney-like structures, narrow spaces and other complex places.

In order to get round such difficulties in operating vibrographs of comparatively long period, we adopted a system of self-levelling. The principle of the self-levelling type of pendulum adopted here is as follows:

(i) the supporting casing of the vibrograph pendulum consists of a simple pendulum,

(ii) in the stable condition a simple pendulum system can keep the bed of the vibrograph pendulum level,

(iii) before setting a vibrograph, its simple pendulum system is free,

(iv) after the supporting bed of the vibrograph pendulum becomes level, the simple pendulum system is fixed by some mechanism.

The details of the construction of this self-levelling vibrographs are explained in the following sections.

2. Self-levelling type of vibrograph pendulum

Fig. 1 shows the schematic figure of the self-levelling type of vibrograph pendulum designed by us. In Fig. 1, (i) a mass and a spring compose a vibrograph pendulum, (ii) string and inner casing enclosing the vibrograph pendulum form a simple pendulum, (iii) paraffin fixes the simple pendulum system to the outer casing, (iv) a heater makes the simple pendulum system free from the outer casing by melting the paraffin and (v) the outer casing is installed at the measuring place.

Next, the operation process of the self-levelling type of vibrograph will be explained. After the transducer has been installed at the observation place, electric current is sent to the heater in order to melt the paraffin which fixes the inner casing to the outer casing. After about 2~4 minutes, the paraffin melts perfectly and at the same time the inner casing forming a simple pendulum becomes free, and then the supporting bed of transducer pendulum becomes level after the inner casing has repeated damped free vibrations. At that moment when the supporting bed of the transducer pendulum has become level, the buzzer sounds because the electric contacts between the vibrograph pendulum and the inner casing are broken. About 1~2 minutes after the buzzer sounds, the electric current of the heater is cut off. Within about ten minutes after the current of the heater is cut off, the paraffin sets satisfactorily and the inner casing is fixed perfectly to the outer casing. Then all is ready for the observation of vibration. It takes about 15 minutes from the time that the transducer is installed.

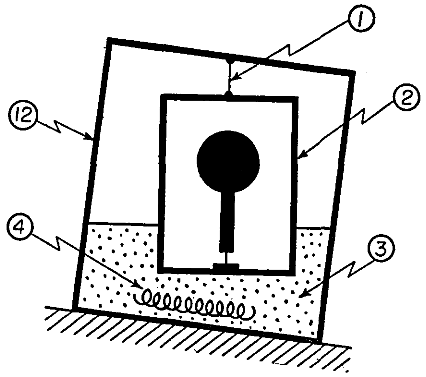


Fig. 1. Schematic figure of the self-levelling system of transducer.
①; hanging string,
②; inner-casing,
③; paraffin,
④; electric heater,
⑫; outer-casing.

3. A self-levelling vibrograph for observation at bored hole-bottom

The plan and the photograph of a self-levelling transducer for observation at 100 mm bored hole-bottom are shown in Figs. 2, 3 and 4. In this design, the natural period of the inverted pendulum is 0.8 sec. In order to make the center of gravity of the inner casing lower, a lead block is set at its bottom, and the natural period of the inner casing becomes about 0.5 sec. As the allowable inclination between the center lines of the inner and outer casings is 15°, the present transducer can be used at the place where the inclination angle is less than 15°. The total weight of transducer is about 4 kg and its sensitivity is 0.58 volt/kine. The overall frequency response curve of the present vibrograph, in which

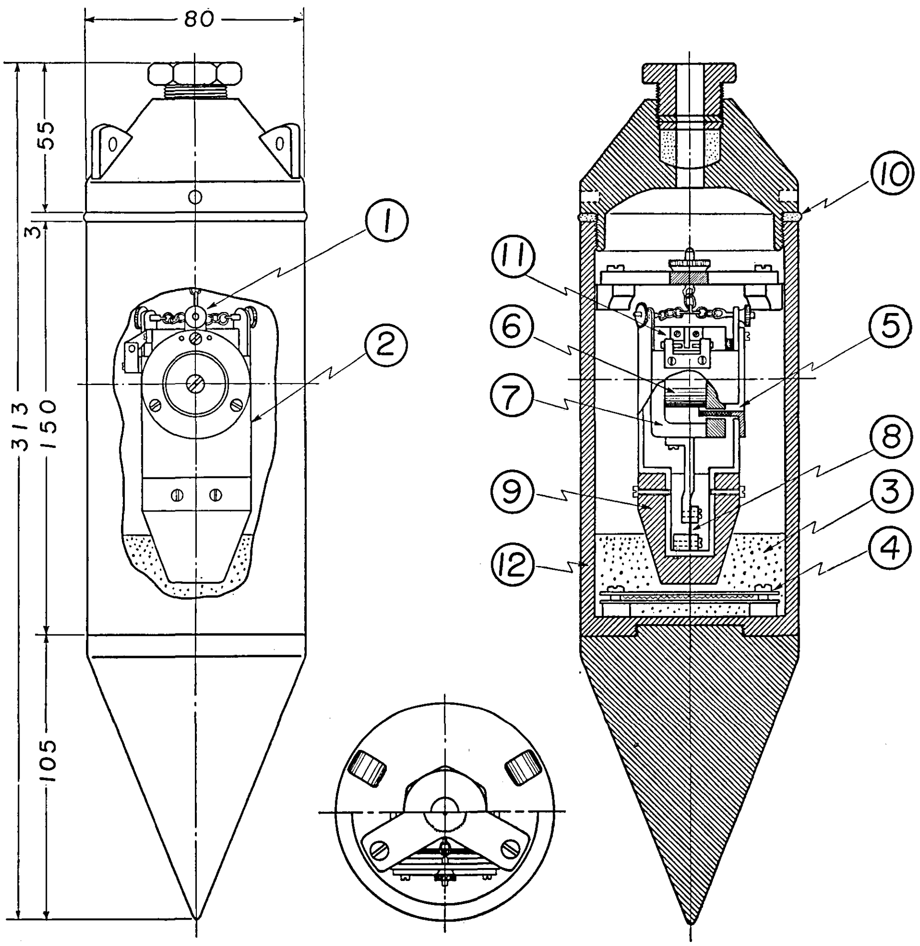


Fig. 2. Plan of the self-levelling transducer for a 100 mm bored hole-bottom. ①; hanging-chain, ②; inner-casing, ③; paraffin, ④; electric heater, ⑤; coil, ⑥; permanent magnet, ⑦; magnetic frame, ⑧; plate spring, ⑨; lead block, ⑩; rubber packing, ⑪; electric contact for buzzer, ⑫; outer-casing.

the transducer is combined with an amplifier and a recoder of the scratching smoked paper type, are shown in Fig. 5.

Simultaneous records of a microtremor at neighbouring places by this vibrograph and a vibrograph of the usual type are shown in Fig. 6. As seen in Fig. 6, the records of the two kinds of vibrograph coincide considerably with each other.

The representative record of an earthquake obtained at a depth of 21 m in a 100 mm bored hole-bottom is shown in Fig. 7. (The results of in-

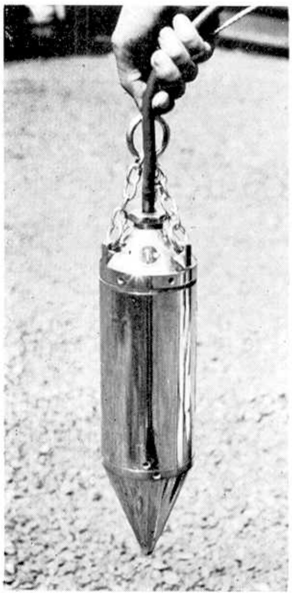


Fig. 3. Self-levelling transducer for a 100 mm bored hole-bottom.

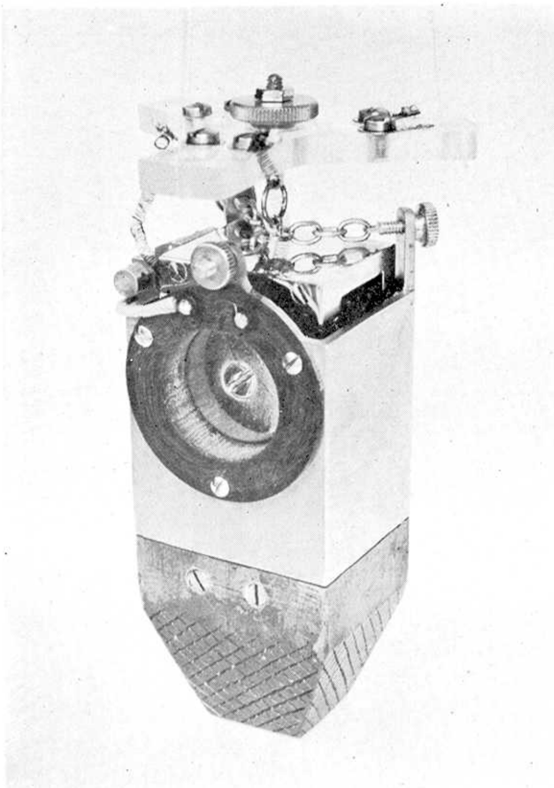


Fig. 4. Inner parts of the self-levelling transducer for a 100 mm bored hole-bottom.

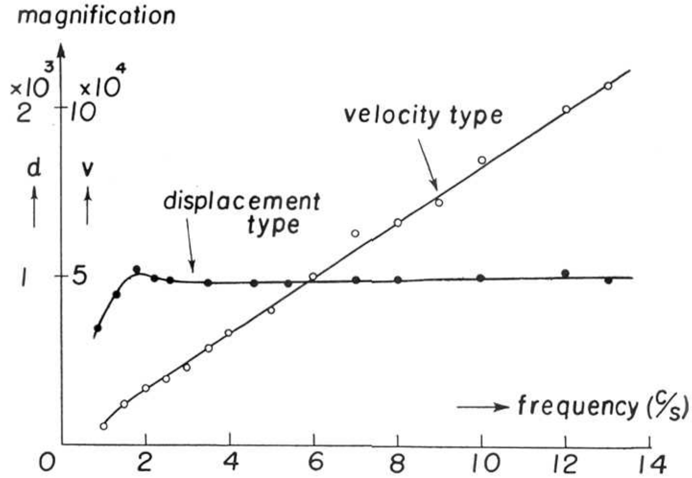
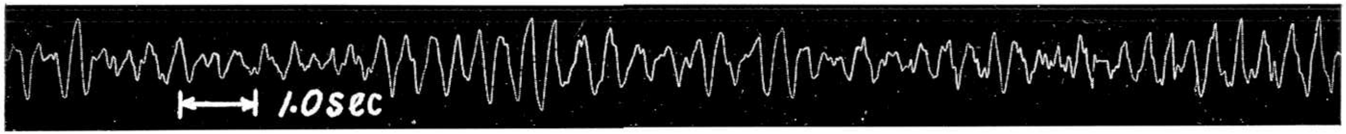
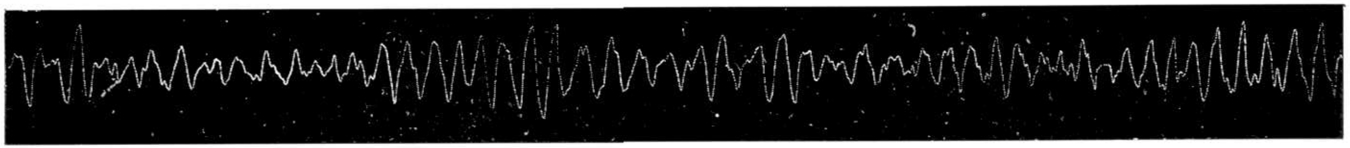


Fig. 5. Overall frequency response curve of the self-levelling vibrograph for a 100 mm bored hole-bottom.



Record of the self-levelling vibrograph for a 100 mm bored hole-bottom.



Record of a vibrograph of the usual type.

Fig. 6. Simultaneous records of a micro-tremor at neighbouring places by two kinds of vibrograph.

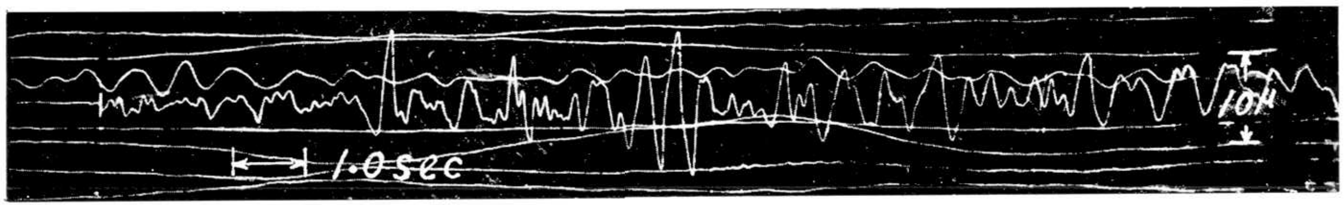


Fig. 7. Representative record of an earthquake obtained at a depth of 21 m in a 100 mm bored hole-bottom.

vestigations concerning these observations will appear in the forthcoming Bulletin.)

4. Self-levelling vibrograph for observation at water-bottom

The plan and the photograph of a self-levelling vibrograph for observations at deep water-bottom are shown in Figs. 8, 9, 10 and 11, respectively. The mechanism of this transducer is somewhat different from that for bored hole use mentioned in the preceding section, because with this the size is scarcely restricted.

The push-pull system of electric circuit consists of two pairs of magnets and coils. The natural period of the inverted pendulum is 1.0

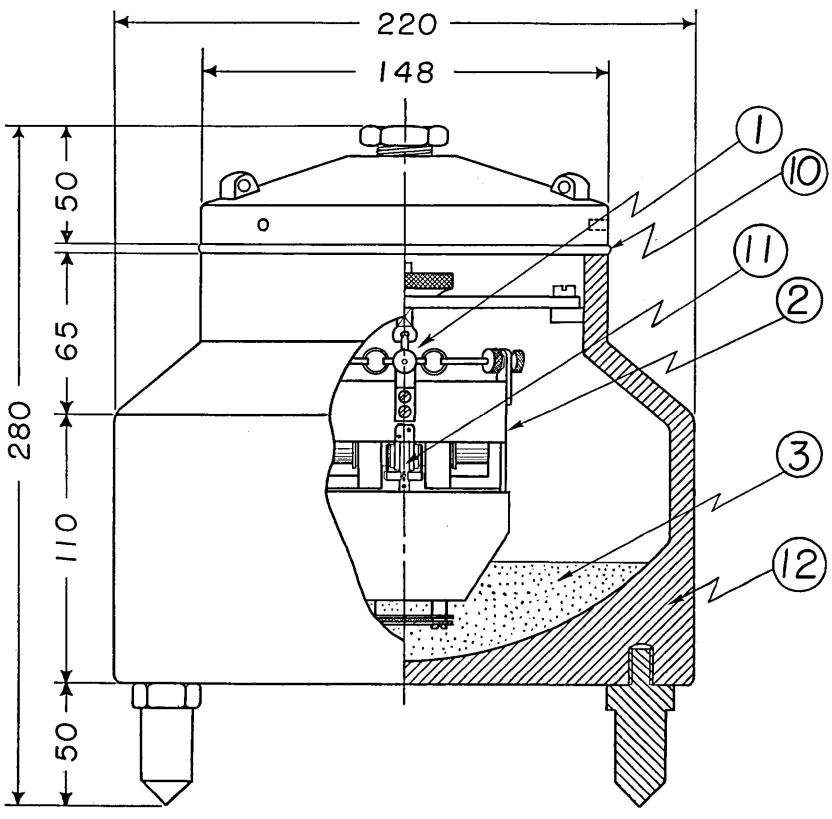


Fig. 8. Plan of the self-levelling transducer for observation at deep water-bottom. ①; hanging-chain, ② inner-casing, ③; paraffin, ⑩; rubber packing, ⑪; electric contact for buzzer, ⑫; outer-casing.

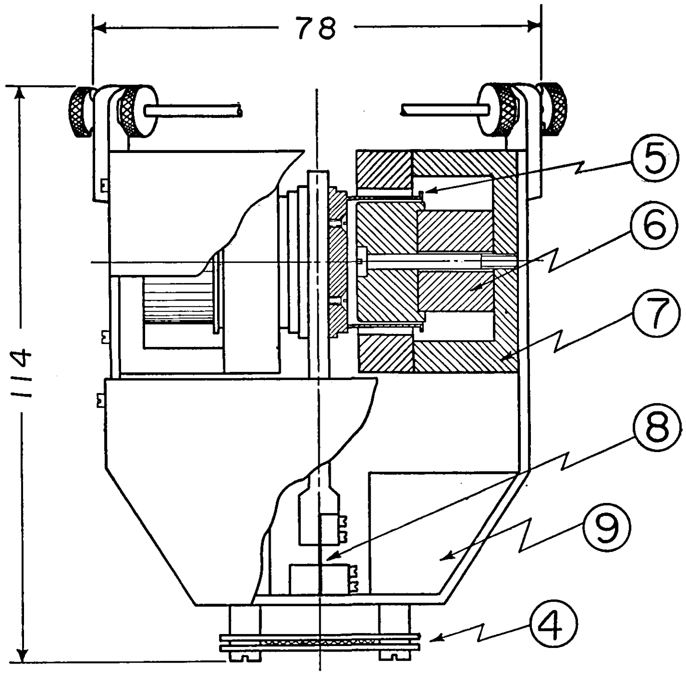


Fig. 9. Plan of the inner parts of the self-levelling transducer for use at deep water-bottom. ④; electric heater, ⑤; coil-bobbin, ⑥; permanent magnet, ⑦; magnetic frame, ⑧; plate spring, ⑨; lead block.

sec. The sensitivity of the transducer is 3.5 volt/kine. The allowable inclination of the place where the transducer will be installed is 45°. The total weight of the transducer is 14.2 kg.

The overall frequency response curve of the vibrograph, in which the transducer is combined with an amplifier and a recorder of the scratching smoked paper type, are shown in Fig. 12.

Simultaneous records of microtremors at neighbouring places by this vibrograph and a vibrograph of the usual type are shown in Fig. 13. As seen in Fig. 13, the vibration-characteristics of two kinds of vibrograph are almost the same.

The representative record of a microtremor at the bottom of the sea of 20 m depth is shown in Fig. 14. (The results of investigations concerning these observations will appear in the forthcoming Bulletin.)

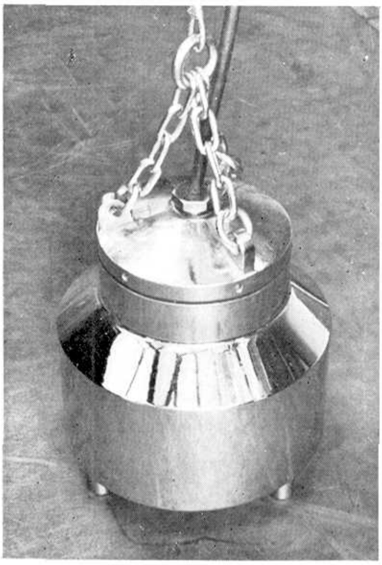


Fig. 10. Self-levelling transducer for deep water-bottom.

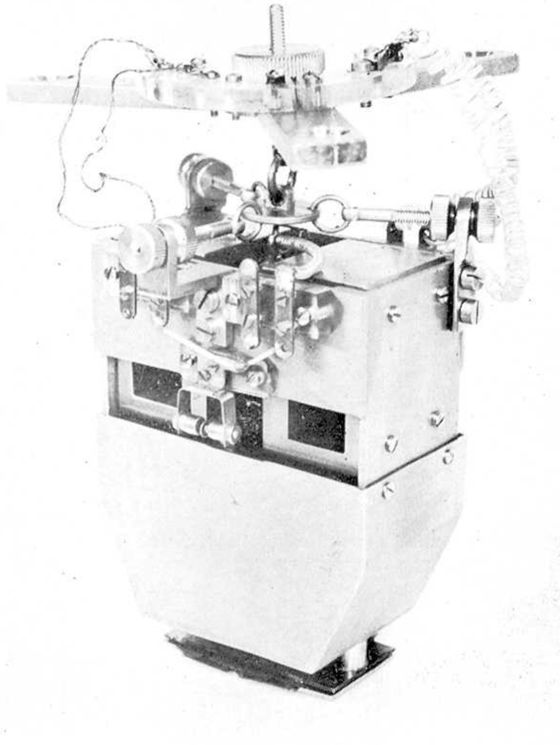


Fig. 11. Inner parts of the self-levelling transducer for deep water-bottom.

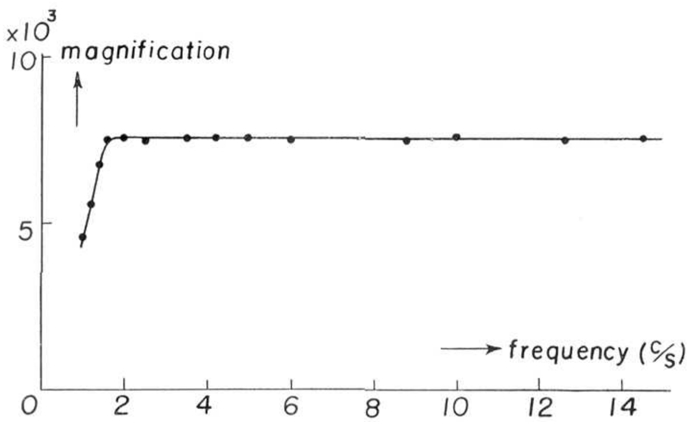
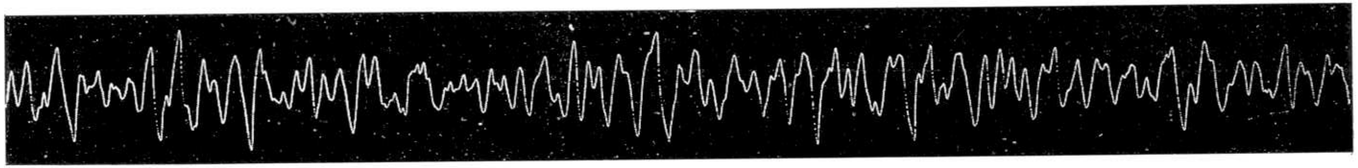


Fig. 12. Overall frequency response curve of the self-levelling vibrograph for deep water-bottom.

Record of the self-levelling vibrograph for deep water-bottom.



Record of a vibrograph of the usual type.

Fig. 13. Seimultaneous records of a micro-tremor at neighbouring places by two kinds of vibrograph.

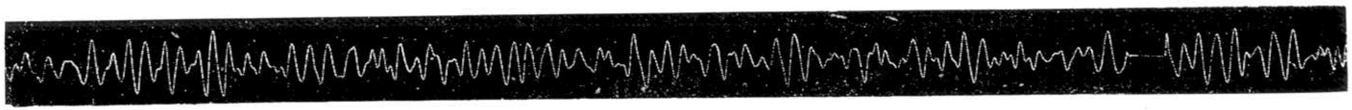


Fig. 14. Representative record of micro-tremor at the bottom of the sea of 20 m depth.