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SOME INEXPENSIVE SEISMOMETER DESIGNS

by

M. Nurmia

Seismological Division, Department of Physics,
University of Helsinki

Abstract

Some seismometer types developed in the years 1956—1959 in Finland are described, and data about their performance are given.

Introduction

During the years 1956—1959, many designs of inexpensive seismometers were studied with the aim of developing types suitable for both routine teleseismic work and the study of weak local shocks. This report describes the horizontal and vertical instruments that emerged from this study and that are now in routine use at the Finnish stations.

Vertical Seismometers

The vertical seismometers designed at the Seismological Station between 1956 and 1959 employ the variable-reluctance principle, i.e. the magnetic flux through a coil is varied by changing the reluctance of the associated magnetic circuit. The best-known example of a seismometer transducer based on this principle is the Benioff transducer (a in Fig. 1). Several practical reasons led to the development of a new system (b in Fig. 1), which may be considered a double Benioff transducer with coils common to both systems. The two magnet systems now form a

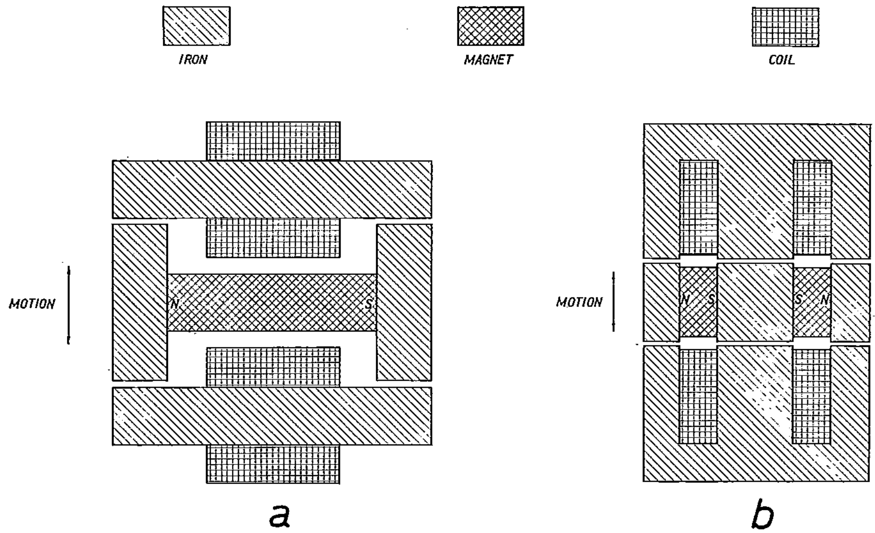

Fig. 1. The Benioff transducer (after Hugo Benioff, Seismographs, in Advances in Geophysics, Vol. II, pp. 219—275 (Academic Press 1955)), and the new transducer.

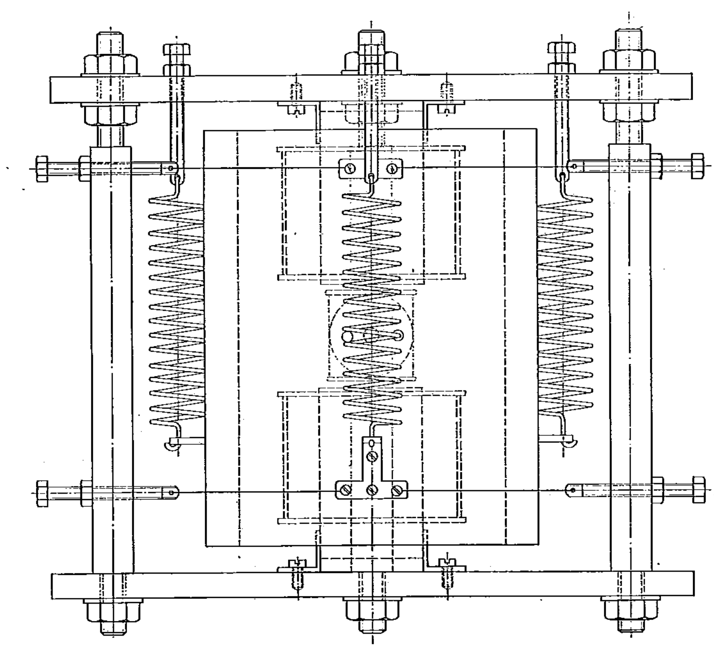

Fig. 2. The new vertical seismometer.

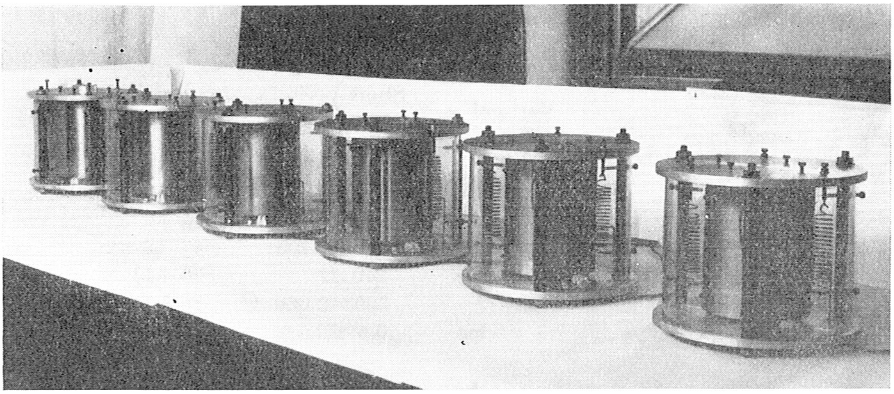

Fig. 3. Vertical seismometers built at the Seismological Station.

»three-pole» magnet with like poles at both ends, while the length of the magnets is considerably reduced to take advantage of modern high-coercivity ceramic magnet materials. The axis of the coils is vertical, and they are wound on standard bobbins which fit the E-type transformer laminations that form the rest of the magnetic circuit.

This transducer is employed in the 100-kg vertical seismometer at Nurmijärvi station, which has been in use since 1958. The outward appearance and properties of the instrument are rather similar to a Benioff vertical seismometer, and photographic recording with a Benioff short-period galvanometer is used.

In 1959, a lightweight seismometer of rather different appearance was designed around a smaller version of the same transducer, and it has since become the standard instrument in seismological research in Finland. Details of this seismometer are given in Table 1, while the instrument is shown in Figs. 2 and 3.

It will be noted that the main part of the moving mass is formed by a mild steel ring that surrounds the transducer providing good screening against magnetic stray fields. The mass is suspended on three springs, and its motion is controlled by two loops of piano wire that are attached to the three vertical posts of the instrument. The period of the seismometer can be varied by changing the tension in these loops by means of the adjusting screws provided.

This instrument is designed for use in connexion with a transistorized amplifier, but the system also gives sufficient output for galvanometer recording if equipped with lower resistance coils.

Table 1

	Seismometer type		
	Vertical	Short-period horizontal	Long-period horizontal
Overall height	30 cm	110 cm	35 cm
Total mass	27 kg	24 kg	18 kg
Moving mass	12 kg	12 kg	12 kg
Period range	0.4—1 sec	0.4—2 sec	4—12 sec
Coil resistance	14 kΩ	240 Ω	20 kΩ
Load resistance	10 kΩ	200—2 000 Ω	10 kΩ
Output	7 v/kine	0.5 v/kine	5 v/kine

The seismometer may be used as a horizontal instrument also by merely removing the three suspension springs and tipping the seismometer on its side. Special levelling screws (not visible in the figures) are attached to it for this purpose.

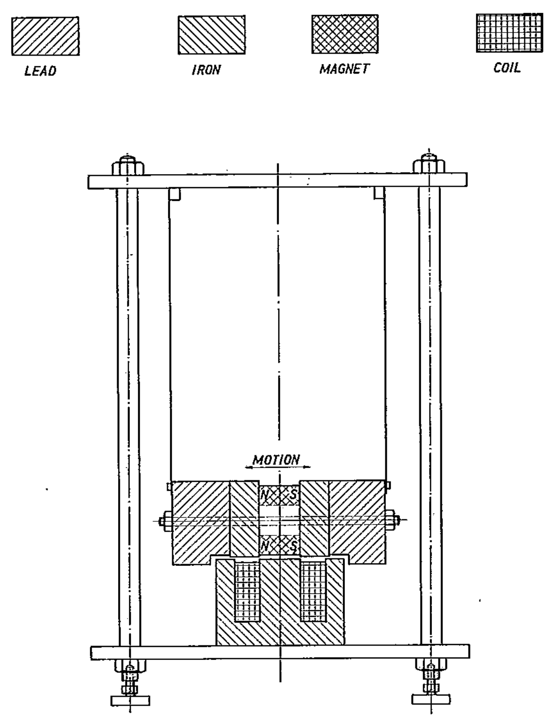

Fig. 4. The short-period horizontal seismometer.

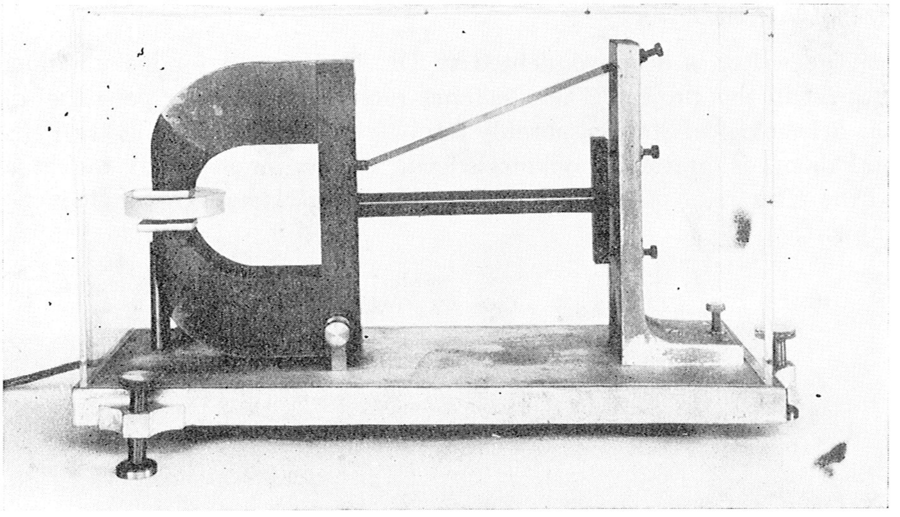

Fig. 5. The long-period horizontal seismometer.

Horizontal Seismometers

A somewhat different transducer is employed in the short-period horizontal seismometers built in 1958 for the Sodankylä and Nurmijärvi stations (Fig. 4). The two-pole magnet now moves laterally with respect to the coil system that is exactly similar to those used in the vertical instruments. Additional mass is provided by lead cylinders attached to both ends of the magnet. The moving part is suspended with four steel ribbons from a frame equipped with leveling screws.

To decrease the influence of the galvanometer circuit on the damping of the seismometer a copper ring is placed on top of the coil. The main properties of this instrument are given in Table 1.

A similar transducer is employed in the geophones that are used in field investigations.

These instruments were designed for photographic recording where the long-period response needed for routine teleseismic work can easily be achieved by an appropriate choice of the recording galvanometer. However, if a transistorized recorder is employed, its linear frequency response makes it advisable to use a longer-period seismometer to obviate the need for a filter circuit. For this end, a very simple moving-magnet electrodynamic seismometer was designed. Its properties are given in Table 1, while the appearance of the instrument is shown in Fig. 5.

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