March 8, 1966 P. T. ELSKAMP ETAL 3,239,804

SEISMOMETER

Filed Aug. 10, 1962 2 Sheets-Sheet 1

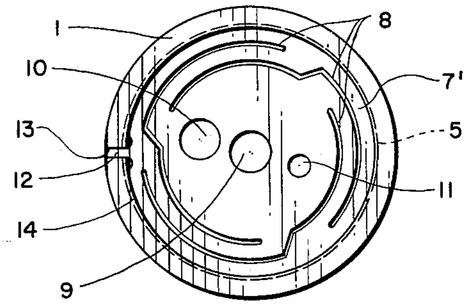

FIG. 2

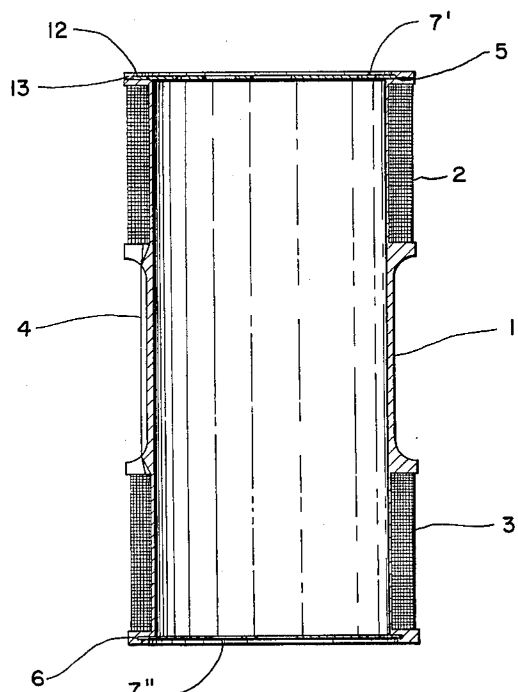

FIG. 1

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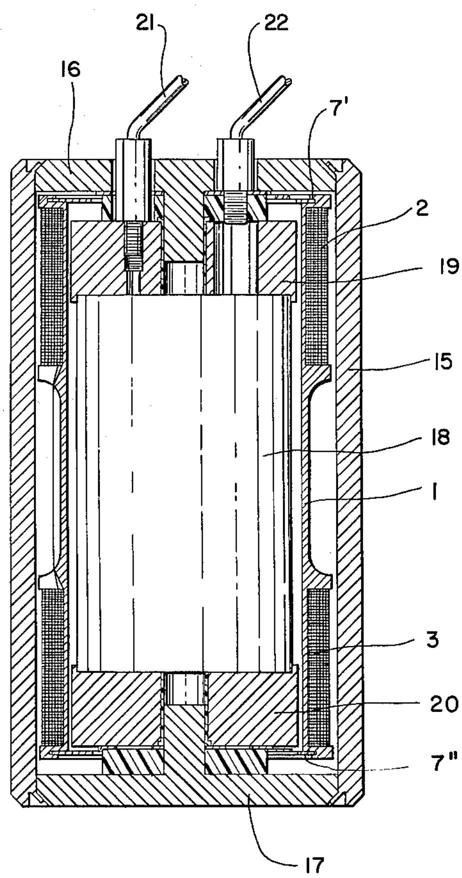

FIG. 3

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3,239,804

SEISMOMETER

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2 Claims. (Cl. 340—17)

The invention relates to an apparatus for measuring earth vibrations or seismometer provided with a coil system capable of moving in a magnetic field and connected to the stationary casing by means of one or more springs. It is known to use for this purpose disc-shaped flat leaf springs whose resilience has been increased, if necessary, by means of incisions. In the known seismometers the circular outer edge of these springs is riveted or screwed to the casing, the central part being secured to the body of the coil.

The object of the invention is to provide a construction for a simple, inexpensive seismometer of small dimensions having other advantages which will be described below. The construction according to the invention has at least one flat disc-shaped leaf spring, but its circular outer edge fits in the body of the coil, i.e. in a groove provided in the inside thereof at a very short distance from the end; in addition, the outer edge of the leaf spring is provided with a small projecting resilient lug fitting in a narrow radial slot of the coil body and capable of being held in the said slot.

This slot is arranged at the end of the coil body and extends at least as far as the groove, the lug is preferably integral with the leaf spring; the latter is usually made from a single thin sheet of resilient material such as phosphor bronze or beryllium copper by etching or stamping. The spring thickness is of the order of 0.1 mm. The central part of the leaf spring is secured to the casing (for example, the magnet of the pole pieces). The slot is preferably as deep as the distance between the bottom side of the slot and the end (about 0.5 mm.). The slot is as thick as or slightly thicker than the leaf spring.

In this way, a cheap construction is obtained permitting a very compact structure as well as a great sensitivity of the seismometer.

The construction according to the invention also has a number of advantages relating to the electrical part of the seismometer. The coil may be electrically connected to the connecting lines in a simpler manner than before by means of one or both springs. It should be noted that it is known per se to use the suspension springs as current conductors.

It is also easy to determine whether the seismometer is properly connected, i.e. with the correct polarity. The relevant method is disclosed in the U.S. Patent 2,423,970. In order to carry out this method, namely, supplying a direct-current voltage from the measuring station as a result of which the seismometer acts as an interrupter in one poling but not in the other, an extra contact is required; with the present seismometer, however, one spring can produce the desired effect through direct contact with the casing (viz. the magnet or a pole piece).

These additional advantages result from the fact that the new construction permits a more efficient use of the insulation which is already present for other reasons (the coil body is insulated; the earth is not used as a return conductor).

In the accompanying drawing, FIG. 1 is a cross-section in elevation of the coil body with two suspension springs.

FIG. 2 is a plan view of FIG. 1.

FIG. 3 is a diagrammatic elevation partially in cross-section of the assembled seismometer.

Referring to FIGS. 1 and 2 of the drawing, the coil body **1** consists of a housing of a non-magnetic material, for example, aluminum, the surface of which is provided with an insulating layer; it is preferred to use a coil body of aluminum which has been anodized afterwards. Two coils **2** and **3** connected by a wire **4** are arranged in the coil body. Each of the ends is provided with a circular groove which, measured radially, makes an incision of about 1 mm. in the coil body and of which the bottom side (the side turned away from the corresponding end of the coil body) is at about 0.5 mm. from the end. A disc-shaped leaf spring **7′**, **7″** fits in each of these grooves. The resilience of this spring is increased by incisions **8**. The spring has a central opening **9** enabling it to be secured to the casing and two openings **10** and **11** for the passage of the terminals for the electrical connection. Each leaf spring also has a projecting resilient lug **12** fitting in a narrow radial slot **13** of the coil body. At one side or, as shown in the drawing, at both sides of the point of projection of the lug is a small incision in the spring which has the effect of making it diverge slightly from the circular shape at this point and enabling it to be fitted in the coil body. FIGS. 1 and 2 show the spring in the position it occupies after being fitted. In order to disassemble the spring it is only necessary to lift the lug **12** until it can be pushed over the edge of the coil body; the spring may then be removed from the coil body by turning it. To mount the spring it is placed on the end of the coil body in such a way that the lug **12** remains on the outer edge, for example, to the left of the slot **13** but close thereto. The edge of the spring **14** is then pressed into the groove and when the spring is rotated to the left it automatically screws into the groove until the lug **12** finally falls into the slot **13** after a complete rotation; thus blocking further movement. Thus, the lug **12**, measured in a radial direction, projects into the slot **13** slightly further than the groove **5**.

The structure of the seismometer is shown diagrammatically in FIG. 3. The casing (stationary part) of the seismometer consists of a hollow iron cylinder **15** closed at the top and bottom by cover plates **16** and **17**, of non-magnetic material, preferably anodized aluminum, which likewise serve as fitting pieces. This cylinder contains a permanent magnet **18** and iron pole pieces **19** and **20**. The coil body **1** is suspended from the two springs **7′**, **7″** between the cylinder **15** and the inside parts **18**, **19** and **20**. The electrical connections are indicated at **21** and **22**. The entire assembly may also be enclosed in a shell, not shown (for example, of aluminum) to ensure watertight sealing.

The electrical circuit is formed by connection **21**, spring **7′**, coil **2**, line **4**, coil **3**, spring **7″**, the inside parts **20**, **18**, **19** and connection **22**. It should be noted that the inside part is electrically insulated from the outside **15** of the seismometer. Hence, the lines **21** and **22** remain insulated from the earth.

The seismometer according to the invention may be mounted in a simple manner by stacking the various parts. The inside parts may be secured to each other and to the iron cylinder by flanging.

In order to determine whether the seismometer is properly connected to the measuring cable a sufficiently high direct-current voltage (from the measuring center) may be provided between the points **21** and **22**. In one method of poling there is a strong downward movement of the coil; the upper spring touches the pole piece **19** and short-circuits the direct current through the coil. As a result the coil body springs back, the current again flows through the coil, etc. This intermittently interrupts the direct current. This interrupted direct current may be made detectable, in the measuring center, for example, audible. In the other method of poling the coil moves upwards but no interrupted direct current is generated. Hence this enables the poling of the seismometer to be checked.

It will be understood that the invention is not limited to seismometers with two coils and/or one magnet; these numbers may vary.

We claim as our invention:

1. A seismometer comprising:
a casing;
a permanent magnet, said magnet being mounted within said casing,
a coil body having at least one coil wound thereon, said coil body in addition having an annular groove formed near one end thereof, said coil body being disposed in said casing;
a flat disc-shaped leaf spring, the center portion of said spring being fixed to said casing and the outer periphery of said spring being retained in said annular groove;
the outer periphery of said spring in addition being provided with a small lug, said lug being retained in a radial slot formed in said coil body.

2. A seismometer comprising:
a cylindrical casing closed at both ends;
a rod shaped permanent magnet, said magnet being disposed in the center of said casing and secured to the end walls thereof;

a cylindrical coil body having at least one coil wound thereon, said coil body in addition having an annular groove formed in its inner surface adjacent one end of said coil body, said coil body being disposed in said casing and surrounding said magnet;
a flat disc-shaped leaf spring, the central portion of said spring being secured to one of the ends of said casing and the outer periphery of said spring being positioned in the annular groove in said coil body;
said spring in addition having a radially projecting lug on its outer periphery, said lug being retained in a recess formed in said one end of said coil body.

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