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CA 2360331 A1 2000/08/17

(21) 2 360 331

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2000/01/28
(87) Date publication PCT/PCT Publication Date: 2000/08/17
(85) Entrée phase nationale/National Entry: 2001/08/08
(86) N° demande PCT/PCT Application No.: EP 00/00656
(87) N° publication PCT/PCT Publication No.: WO 00/47439
(30) Priorité/Priority: 1999/02/09 (199 06 162.9) DE

(51) Cl.Int.^{7}/Int.Cl.^{7} B60L 5/28
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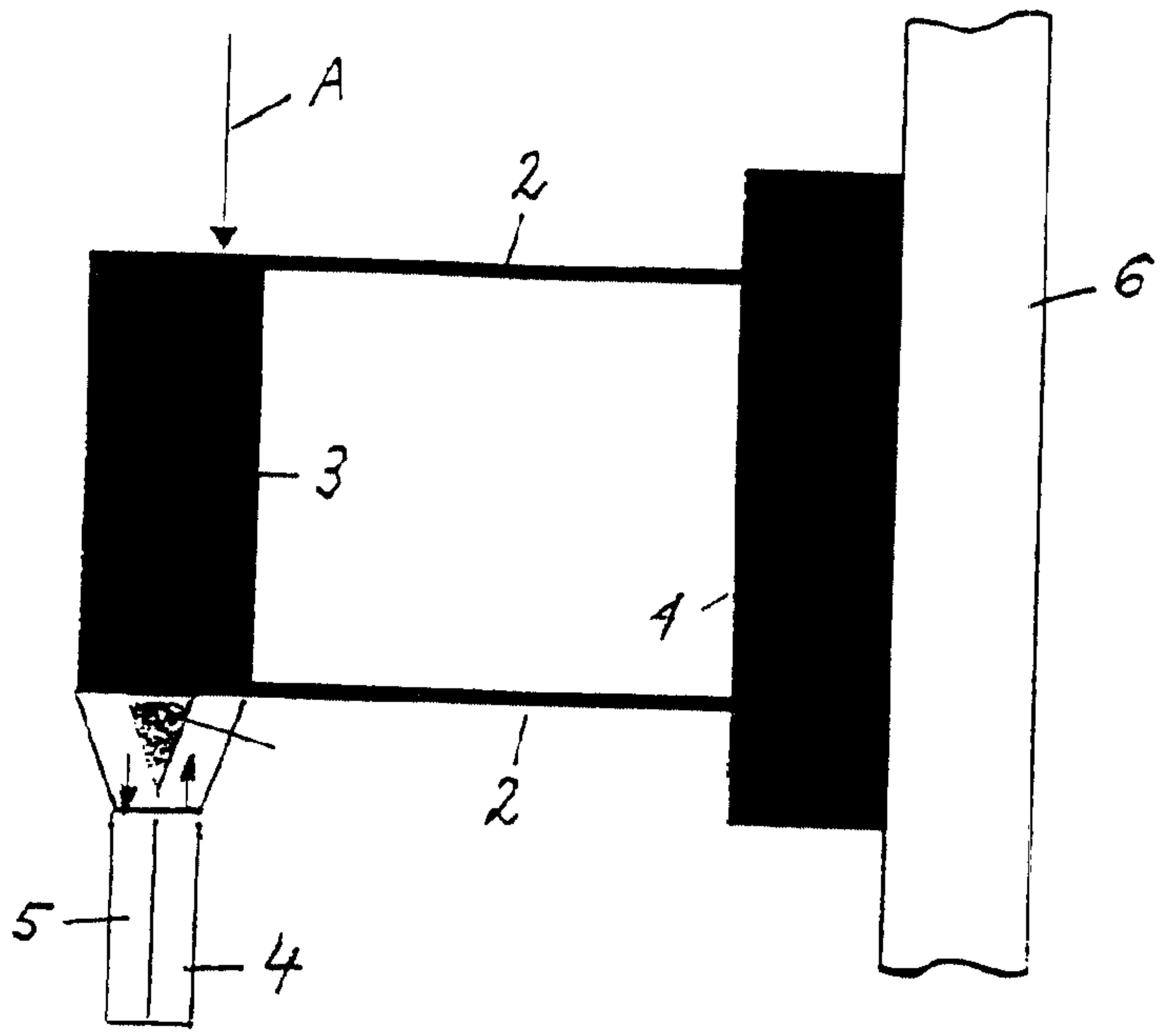
(54) Titre : DISPOSITIF PERMETTANT DE DETERMINER LA PRESSION ENTRE UN FIL CONDUCTEUR ET UN DISPOSITIF DE PRISE DE COURANT

(54) Title: DEVICE FOR DETERMINING THE PRESSURE BETWEEN A CONTACT WIRE AND A PANTOGRAPH



(57) Abrégé/Abstract:
A device for determining the pressure between a contact wire and a pantograph of an electrically-powered vehicle is provided with a measuring device for the static pressure, which is determined based on the distance between two elastically interconnected components of the pantograph, this being dependant on the static pressure; and an acceleration sensor which is coupled with the pantograph in order to determine the accelerations of the pantograph in the direction of the pressure. The output signal of the acceleration sensor is combined with the output signal of the measuring device in order to calculate the pressure. The acceleration sensor is configured in such a way that it has a seismic mass (3) which is spring-mounted on the pantograph (6). The position of the seismic mass in relation to the pantograph is detected optically and a corresponding optical signal is then transmitted to an optoelectrical converter which is separate from the pantograph in terms of potential.

Abstract

A device for determining the contact pressure between a contact wire and a pantograph of an electrically powered vehicle is provided with a measuring device for the static contact pressure, which is determined from the distance between two elastically connected components of the pantograph, which is dependent on the contact pressure, and with an acceleration sensor that is coupled to the pantograph and used to determine the accelerations of the pantograph in the direction of the contact pressure. The output signal from the acceleration sensor is combined with the output signal from the measuring device in order to calculate the contact pressure. The acceleration sensor is so configured that it incorporates a seismic mass (3) that is spring mounted on the pantograph (6), the particular position of which in relation to the pantograph is determined optically and a corresponding light signal is transmitted to an optoelectronic converter that is separate from the pantograph in terms of potential.

Device for Determining the Pressure between a Contact Wire and a Pantograph

The present invention relates to a device as defined in the preamble to Claim 1.

With respect to the contact pressure that exists between the wear strips of pantographs and the contact wire, the pantographs used for modern high-speed rail vehicles should be designed as actively controlled pantographs so as to arrive at and maintain the optimum between the contact wire and the wear strip—regardless of the relative movement between the rail vehicle and the contact wire, the aerodynamic forces acting on the parts of the pantograph, which result from the wind and the speed of the vehicle, as well as the oscillatory behaviour of the pantograph, the contact wire, and the system that supports it—for a specific quality of the power supply and the wear at the point of contact between the contact wire and the wear strip. Although the fraction of the true contact pressure—which results from the airflow that is dependent on the speed of the vehicle on the parts of the pantograph—can be determined by measurement and used as a parameter function for a control algorithm, determining the contact pressure resulting from the mechanical action of the pantograph and the overhead-wire system requires a device that determines this contact pressure as close as possible to the point of contact, according to its amount and its point of contact, sends signals that are equivalent to the contact pressure from the point of measurement, which is at the high-voltage level (e.g., 3 kV DC; 15kV or 25 kV AC), to an evaluation and analysis system that is located inside the vehicle and is at the opposite potential.

PCT 98/DE 01657 describes a device for measuring the contact pressure between a contact wire and a pantograph of an electrically-powered vehicle, in particular an electric rail vehicle that is provided with at least one fibre-optic sensor for determining the contact pressure between the contact wire and a wear strip of the pantograph, a device for controlling the sensor and processing the sensor signals, and an optical-fibre device for connecting these for the transmission of signals that are separated by potential. The fibre-optic sensor should be arranged so as to be as close as possible to the actual point of contact between the pantograph and the contact wire, and be able to measure the forces acting between the pantograph and the contact wire directly, without significant relative travel between them. The oscillatory and the aerodynamic behaviour of the pantograph should remain largely undisturbed by the measuring device. It should be possible to determine the amount of the contact pressure and its point of application on the wear strip, and generate signals that are equivalent to the contact pressure and can be used for an actively controlled pantograph.

To this end, between a base body of the wear strip and a wear-strip support (rocker frame) or a skate and the base body of the wear strip, connected rigidly to each, there are two elastically deformable bodies; these support the wear strip or the skate. A fibre-optic reflex sensor is integrated into each of these, and this detects deformations of the deformable bodies—which is equivalent to the contact pressure—and passes them to the device for controlling the sensor and for processing the sensor signals, in which the deformations that have been detected are converted to signals that are equivalent to the contact pressure and then emitted, or from which the desired commands that are equivalent to changes in the contact pressure are derived and then emitted.

If the elastically deformable bodies are arranged between the skate and the base body of the wear strip, this entails the advantage that the forces that act on the base body as ascending or descending forces that are generated by the airflow, which depends on wind speed and the speed of the vehicle, are taken into account during measurement. However, this solution is more costly from the standpoint of construction than if the deformable bodies are arranged between the base body of the wear strip and the wear-strip support. In addition, it has been found that these aerodynamic forces can be largely disregarded.

It has, however, been found that because of the vibrations of the contract wire and the pantograph that occur when the vehicle is moving, acceleration forces that cannot be taken in to account by known measuring devices are generated, even though the actual contact pressure can increase or decrease considerably relative to the measured "static" contact pressure. These acceleration forces can be calculated from the product of the mass and acceleration of the wear strip. Since the mass of the wear strip is known, determination of the acceleration will suffice to establish the influence of the (positive or negative) acceleration of the pantograph on the contact pressure.

Measurement of the acceleration of the pantograph that occurs in the direction of the contact pressure is made with piezoelectric or capacitative acceleration sensors. These, however, are at the potential of the pantograph, i.e., at a high voltage level, and generate electrical signals that must be reduced to the potential of the evaluation device by potential separation. Potential separation of this kind is associated with very high costs, degrades the quality of the signals, and permits only a small frequency of measurement because of repeated filtering.

Thus, it is the objective of the present invention to describe a device for determining the contact pressure between a contact wire and the pantograph of an electrically powered vehicle, with a measuring device for the static contact pressure as determined by the distance between two components of the pantograph that are connected to each other and which are connected to each other electrically, and with an acceleration sensor the is connected to the pantograph and used to determine the acceleration of the pantograph that takes place in the direction of the contact pressure, the output signal of which is combined with the output signal from the measurement device in order to calculate the contact pressure, in which the advantages inherent in the former separation of potential are eliminated so that more precise determination of the contact pressure is made possible at a much lower cost.

According to the present invention, this objective has been achieved by the features set out in the preamble to Claim 1. Advantageous developments of the device according to the present invention are set out in the secondary claims.

Because of the fact that the acceleration sensor has a seismic mass (3) that is spring-mounted on the pantograph (6), whose position at any one time is determined optically, and because of the fact that a corresponding light signal is transmitted to an optoelectrical converter that is separate from the pantograph in terms of potential, the separation of potential is effected by simple means and without affecting the light signals on the optical path.

It is preferred that the transmission of the light signal be effected by way of an optical fibre, so that the optoelectrical converter can be positioned anywhere in the vehicle.

A fibre-optic reflex sensor with a transmitting optical fibre and a receiving optical fibre is particularly suitable as an acceleration sensor; the light emitting surface of the transmitting optical fibre and the light inlet surface of the receiving optical fibre are opposite a reflective surface of the seismic mass and are fixed in relation to the pantograph.

The accelerations that are significant for the contact pressure have a maximal frequency of 20 to 25 Hz, so that the measurement range should lie between less that 1 Hz and 25 Hz. Accelerations at a higher frequency than 25 Hz are of such small amplitude that they can be disregarded. Accordingly, a resonance frequency that amounts to at least 80 Hz can be selected for the acceleration sensor. Too high a resonance frequency degrades sensitivity for the lower frequencies in measurement range, particularly those that are below 1 Hz.

The present invention will be described in greater detail below on the basis of an embodiment shown in the drawing appended hereto. This drawing shows the construction of an acceleration sensor that is coupled to a pantograph as know from PCT 98/DE 01657, cited heretofore.

Essentially, the acceleration sensor comprises a housing 1, only part of which is shown in Figure 1, a seismic mass 3 that is accommodated in the housing and linked to it through springs 2, and rigidly attached to the housing and passing into it, an optical fibre that consists of a transmitting optical fibre 4 and a receiving optical fibre 5. The housing 1 is rigidly connected to a component 6 of the pantograph, for example, the rocker frame or the wear strip. Thus, the housing 1 and the optical fibre move synchronously with the pantograph. In contrast to this, the seismic mass mimics and lags behind the movements of the wearing strip because it is spring mounted.

The transmitting optical fibre 4 and the receiving optical fibre 5 are arranged parallel to each other at a predetermined distance apart, preferably immediately adjacent to each other, such that their end faces that are located within the housing, i.e., the light exit surface or the light entrance surface, are parallel to a light-reflecting surface of the seismic mass 3 that faces them. The transmitting optical fibre 4 guides a transmitting light beam that is emitted from a light source within the vehicle and this emerges from its end surface and strikes the reflecting surface of the seismic mass 3. This light is then reflected, when part of the reflected light strikes the end surface of the light receiving optical fibre 5 and is conducted by this to an optoelectrical converter, within which a corresponding electrical signal is generated for further processing.

The ratio of the quantity of light that arrives on the light entrance surface of the receiving optical fibre 5 to the quantity of light that emerges from the transmitting optical fibre 4 depends on the distance between the end of the optical fibre and the reflecting surface of the seismic mass 3. Since this lags behind the movements of the pantograph and thus of the optical fibre, when the pantograph accelerates this distance will change, and the magnitude of this change will depend on the acceleration. Thus, the strength of the light signal recorded by the receiving optical fibre and then passed on to the optoelectrical converter is a function of positive or negative acceleration when the pantograph is oscillating. By converting this into an electrical signal and multiplying it by the known mass of the pantograph, one obtains either a positive or a negative component that is added to the static contact pressure that has been obtained, for example, from the measuring device described in PCT 98/DE 01675, so as to arrive at the actual contact pressure between the contact wire and the pantograph. The arrow A shown in the Figure indicates the direction of the contact pressure, i.e., the seismic mass 3 oscillates in the direction of the contact pressure, so that only acceleration of the pantograph in this direction is taken into account.

The acceleration sensor is at the electrical potential of the contact wire. Since, however, the optical fibre is an electrical insulator, there is a separation of potential between the acceleration sensor and the optoelectrical converter, so that its output null signal can be set at a desired potential value.

Patent Claims

1. Device for determining the contact pressure between a contact wire and the pantograph of an electrically powered vehicle, with a measuring device for the static pressure, which is determined based on the distance between two elastically interconnected components of the pantograph, said distance being dependent on the static contact pressure, and with an acceleration sensor that is connected to the pantograph in order to determine the acceleration of the pantograph in the direction of the pressure, the output signal of which is combined with the output signal of the measuring device so as to calculate the contact pressure, characterized in that the acceleration sensor incorporates a seismic mass (3) that is spring-mounted on the pantograph (6), whose position is detected optically, a corresponding light signal being passed to an optoelectrical converter that is separated from the pantograph in terms of potential.

2. Device as defined in Claim 1, characterized in that an optical fibre conductor (4, 5) is used to transmit the light signal.

3. Device as defined in Claim 1 or Claim 2, characterized in that the seismic mass (3) is spring-mounted in a housing (1) that is rigidly connected to the pantograph (6).

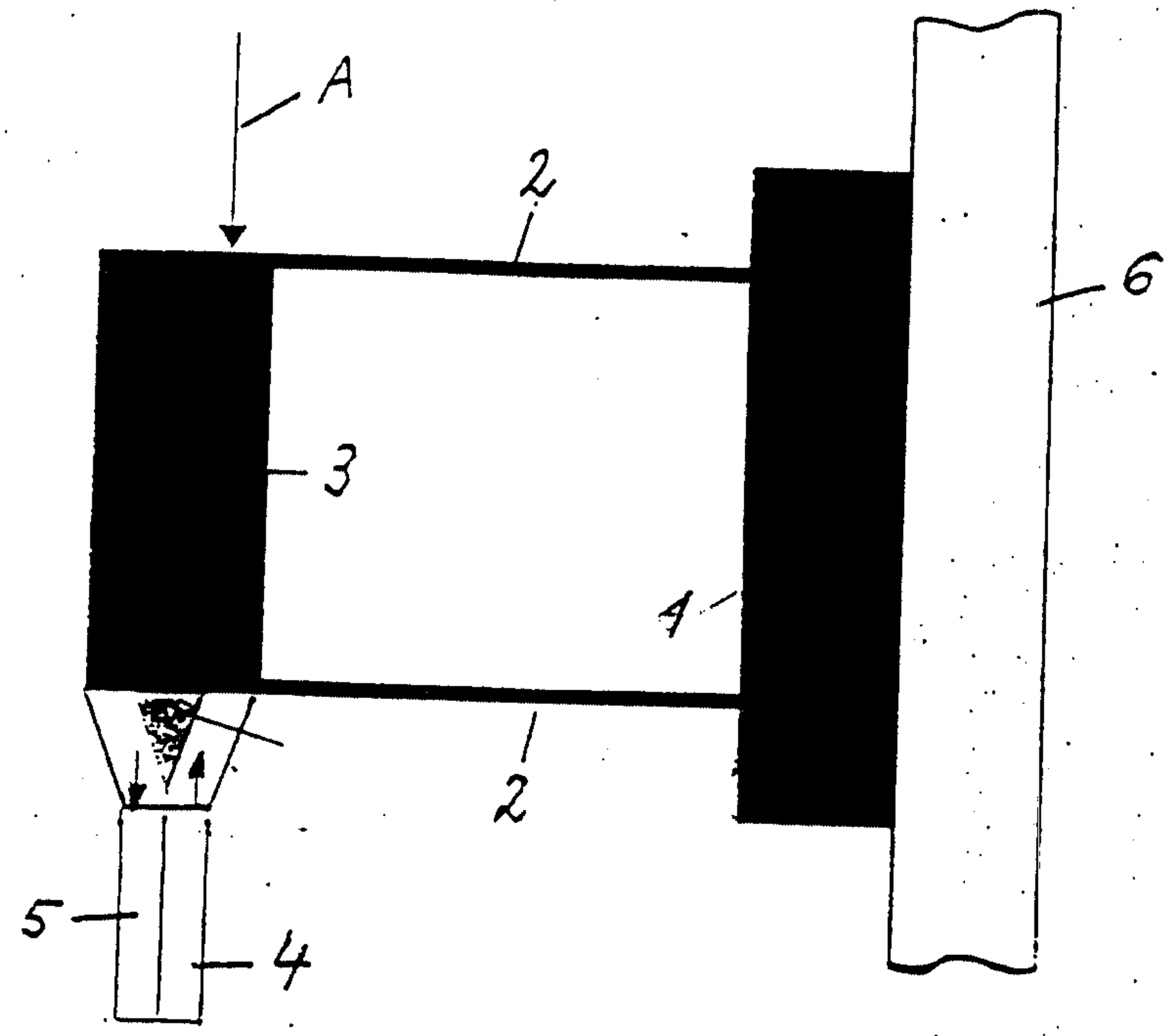
4. Device as defined in one of the Claims 1 to 3, characterized in that a fibre-optic reflex sensor with a transmitting optical fibre (4) and a receiving optical fibre (5) is provided for

the optical detection of the position of the seismic mass (3), the light exit surface of the transmitting optical fibre (4) and the light entrance surface of the receiving optical fibre (5) being opposite a reflecting surface of the seismic mass (3) and fixed in position relative to the pantograph (6).

5. Device as defined in Claim 4, characterized in that the ratio of the quantity of light entering the receiving optical fibre (5) to the quantity of light emerging from the transmitting optical fibre (4) depends on the distance of the reflecting surface of the seismic mass (3) from the light entrance and light exit surfaces of the reflex sensor.

6. Device as defined in one of the Claims 1 to 5, characterized in that the measurement range of the acceleration sensor is below 25 Hz.

7. Device as defined in Claim 6, characterized in that the resonance frequency of the acceleration sensor is greater than 80 Hz.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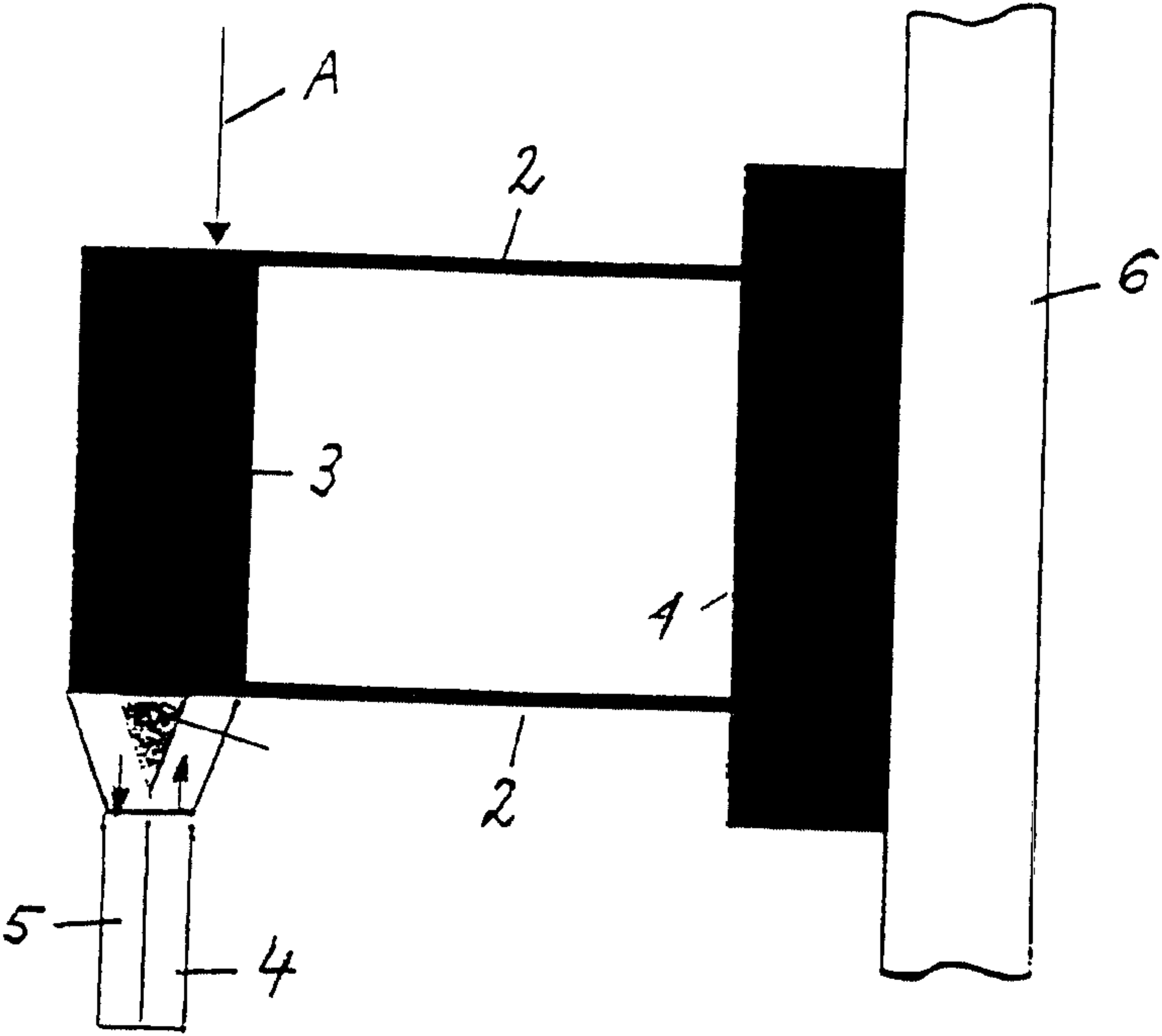
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