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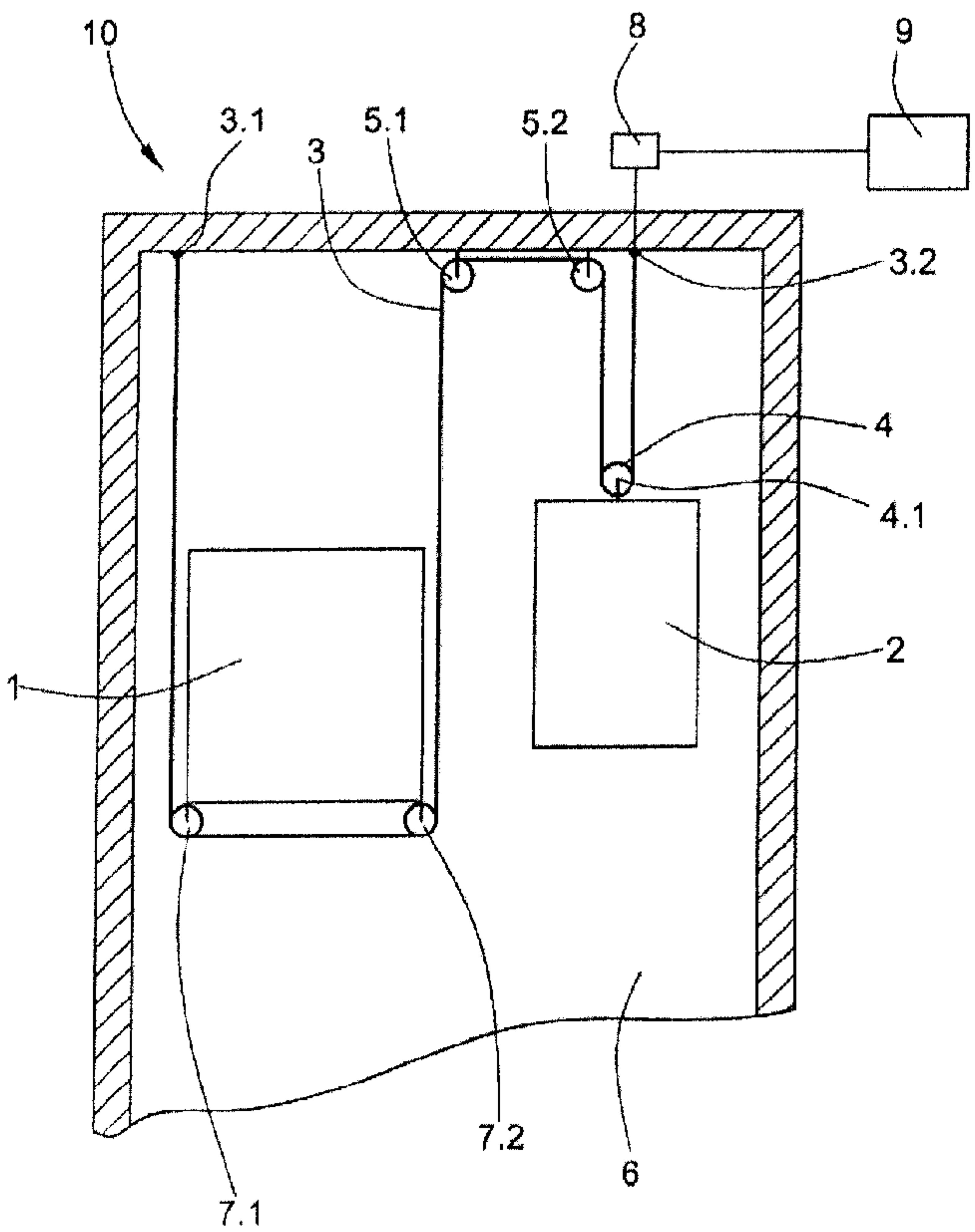
(54) **Titre : INSTALLATION D'ASCENSEUR POURVUE D'UN CAPTEUR ACOUSTIQUE POUR DETECTER DES BRUITS DE STRUCTURE**

(54) **Title: ELEVATOR SYSTEM HAVING A SOUND RECEIVER FOR CAPTURING SOLID-BORNE SOUND**



(57) **Abrégé/Abstract:**
The invention relates to an elevator system (10) having a car (1), a counterweight (2) balancing out the car (1), and a support and/or drive means (3) on which the car (1) and the counterweight (2) are suspended. The elevator system is characterized in that a sound receiver (8) is coupled to the elevator system (10) and is designed to capture solid-borne sound generated at the counterweight (2).

ABSTRACT

The invention relates to an elevator system (10) having a car (1), a counterweight (2) balancing out the car (1), and a support and/or drive means (3) on which the car (1) and the counterweight (2) are suspended. The elevator system is characterized in that a sound receiver (8) is coupled to the elevator system (10) and is designed to capture solid-borne sound generated at the counterweight (2).

Elevator system having a sound receiver for capturing solid-borne sound

The present invention relates to an elevator system having a sound receiver for capturing solid-borne sound and to a method for operating such an elevator system.

In an elevator system having a car and a counterweight for balancing out the weight of the car, the counterweight is typically suspended from a supporting means and/or driving means via a bearing and is guided on guide rails by means of guide elements. Such bearings and guide elements may be the starting point for a fatal malfunction of the elevator system. This is because when these elevator components fail, the counterweight can either drop or tilt on the guide rails and become stuck. Both cases led to damage and to costly repair of the elevator system.

The above problem would be remedied by monitoring the functional capability of these elevator components on the counterweight, namely that of the bearing and of the guide elements.

In a conventional elevator system, the car is supplied with electrical energy. This typically takes place by means of a suspension cable which connects the car to a power network. However, such a power supply is not provided for the counterweight.

The invention is therefore based on the object of developing a means of monitoring elevator components on the counterweight, in particular a bearing or a guide element, while taking into account the specific power supply requirements of the counterweight.

According to one aspect, an elevator system has a car, a counterweight balancing out the car and a supporting and/or driving means from which the car and the counterweight are suspended. The elevator system is defined by the fact that a sound receiver is coupled to the elevator system and is designed to capture solid-borne sound which is generated at the counterweight.

An advantage of such an elevator system is that elevator components which are located at the counterweight can easily be monitored by means of the sound receiver. This is because the sound receiver can be positioned at a location in the shaft which is easy to supply with power. As a result, there is no need for a costly power supply of the counterweight. In this context, the sound receiver can be particularly easily coupled to the supporting and/or driving means or to a guide plane of the counterweight. Both the supporting and/or driving means and the guide plane of the counterweight, for example a guide rail, transmit solid-borne sound from the counterweight to the sound receiver.

According to a further aspect, the supporting and/or driving means forms, between one of its first ends and a first deflection pulley, a loop in which the counterweight is suspended via a bearing.

An advantage of such 2:1 suspension of the counterweight is the use of relatively small drives, wherein the driving power which has to be provided by the drive is approximately halved. However, a person skilled in the art has the choice of suspending the counterweight 1:1, that is to say directly suspended at one end of the supporting and/or driving means, or with some other suspension ratio which is higher than 2:1, that is to say for example 3:1 or 4:1.

In the case of a 2:1 suspension of the counterweight, the counterweight is typically suspended from a counterweight supporting pulley in the loop of the supporting and/or driving means. The connection between this counterweight supporting pulley and the counterweight is implemented by means of a bearing. The bearing forms here a rotational axis about which the counterweight supporting pulley rotates. The bearing of the counterweight supporting pulley is subject to a progressive ageing process which can lead to functional failure of the bearing. It is therefore possible, for example, that the connection between the counterweight supporting pulley and the bearing becomes released and the counterweight falls.

The play between the bearing and the counterweight supporting pulley and the rotational movement of the counterweight supporting pulley itself generate vibrations which are in a typical frequency range and/or amplitude range. The vibrations change over the course of time and with increasing wear of the bearing and/or the counterweight supporting pulley. The vibrations are transmitted as solid-borne sound to the sound receiver via the supporting and driving means or the guide plane of the counterweight. In this context, the vibrational profile of the sound receiver, plotted against the time, is acquired.

According to a further aspect, the counterweight is guided on a guide plane by means of at least one guide element. In this context, the guide element can be a guide shoe, a guide pulley or the like. Furthermore, the guide plane is implemented as a guide rail or as a guide cable or the like.

The guiding of a counterweight by means of guide elements on a guide plane is necessary for safety reasons. Guiding in this way keeps the counterweight on a predefined movement path and prevents inadmissible oscillation of the counterweights in the shaft.

A guide shoe or a guide pulley is subjected to a wearing process and an ageing process over a progressive period of use. Therefore, for example guide faces of the guide shoe or the bearings of the guide pulley become worn. The wear on these guide elements can lead to functional failure, wherein the reliable guiding of the counterweight is possibly no longer ensured.

There is play between the guide element and a guide face. This play gives rise to vibrations during movement of the counterweight, which vibrations are propagated as solid-borne sound, for example, in the guide rails or via suspension bearings of the counterweight in the supporting and/or driving means.

During fault-free operation with an intact functional capability of the guide elements, the vibrations between the guide elements and, for example, a guide rail in a characteristic frequency range and/or amplitude range. As the wear of the guide elements and/or the guide face progresses, this frequency range or amplitude range changes correspondingly. These changes in the vibrational behavior can be captured by the sound receiver via transmission of solid-borne sound.

According to a further aspect, the sound receiver is coupled to the first end of the supporting and/or driving means.

The advantage of this sound receiver arrangement is that one end of the supporting and supporting means is stationary with respect to its suspension point, i.e. that the sound receiver can be particularly easily coupled to the end of the supporting and/or driving means.

Alternatively, the sound receiver is coupled to the guide plane of the counterweight. In this arrangement also, the sound receiver can be particularly easily mounted on an elevator component, such as, for example, a guide rail, which is stationary with respect to the movement path of the counterweight.

According to a further aspect, an evaluation circuit is connected to the sound receiver and evaluates the captured solid-borne sound. The evaluation circuit has at least one processor and one memory unit.

The invention also relates to a method for operating the above elevator system, wherein the sound receiver captures solid-borne sound which is generated at counterweight and transmitted by means of the supporting and/or driving means. The evaluation circuit preferably evaluates the captured solid-borne sound.

The solid-borne sound which is captured by the sound receiver is evaluated in terms of frequency and/or amplitude as a frequency spectrum by means of the evaluation circuit. The evaluated frequency spectrum is compared with at least one frequency spectrum which is stored in the evaluation circuit and which constitutes an operating value. In this context, the evaluation of the solid-borne sound and the comparison of the frequency spectrums is performed in the processor. The stored frequency spectrum and/or the operating value are/is stored in the memory unit.

The stored frequency spectrum can correspond to a frequency spectrum which comprises at least the characteristic frequencies and/or amplitudes of the elevator component to be monitored during permissible operation. This involves a permissible operating value. If the evaluated frequency spectrum corresponds to the stored frequency spectrum, a positive evaluation result is then present here. The permissible operating value is then retained.

Alternatively, the stored frequency spectrum can constitute a non-permissible operating value. The frequency spectrum here also comprises at least those characteristic frequencies and/or amplitudes which occur during non-permissible operation of the elevator component to be monitored. A positive evaluation result is then present here as long as the evaluated frequency spectrum does not correspond to the stored frequency spectrum. The non-permissible operating value is therefore not reached.

In one preferred embodiment, a plurality of frequency spectrums which constitute a permissible and/or a non-permissible operating value are stored in the evaluation circuit. In this case, the evaluated frequency spectrum is compared with a plurality of stored frequency spectrums. If the evaluated frequency spectrum corresponds to one of the stored frequency spectrums of a permissible operating value or for as long as the evaluated frequency spectrum does not correspond to one of the stored frequency spectrums of a non-permissible operating value, a positive evaluation result is present. The evaluation result preferably includes here the mode of operation of the elevator system, such as, for example, a normal operating mode or a maintenance mode which are assigned to a permissible operating value. In addition, the evaluation result comprises the information as to which elevator component, for example a bearing or a guide element, has reached the non-permissible operating value.

According to a further aspect of the method, the evaluation circuit compares the captured solid-borne sound with an operating value and triggers a change-in state alarm when an operational fault is detected. In particular, the evaluation circuit compares the captured solid-borne sound with a permissible operating value and triggers the change-in-state alarm in the case of deviation from the permissible operating value. Alternatively, the evaluation circuit compares the captured solid-borne sound with a non-permissible operating value and triggers a change-in state alarm if the non-permissible operating value is reached.

The change-in-state alarm indicates that the elevator component which is to be monitored, such as, for example, a bearing or a guide element of the counterweight, should be replaced or repaired.

Accordingly, both a damaged bearing, by means of which the counterweight is suspended from the driving and/or supporting means, and a damaged guide element, which guides the counterweight on the guide plane, trigger the change-in-state alarm.

According to a further aspect of the method, in the case of a change-in-responsibility alarm the elevator system is made available for maintenance work. In this context, a maintenance technician is informed to perform maintenance on the elevator system. The change-in-responsibility alarm preferably provides the information as to which of the elevator components to be monitored has reached the non-permissible operating value. This simplifies the fault diagnostics and shortens the maintenance work.

According to a further aspect of the method, in the case of a change-in-responsibility alarm the elevator system is deactivated. Deactivating the elevator system permits the appearance of a fatal malfunction to be prevented. As a result, the deactivated elevator system is made available for maintenance work.

In the text which follows, the invention will be clarified and described further by means of exemplary embodiments and a drawing, in which:

Fig. 1 shows a first embodiment of the elevator system with a sound receiver for capturing solid-borne sound which is generated by malfunction of an elevator component at the counterweight.

Fig. 1 shows an elevator system 10. This elevator system has a car 1, a counterweight 2, a supporting and driving means 3, from which the car 1 and the counterweight 3 are suspended with a 2:1 ratio and via a drive pulley 5.1. The drive pulley 5.1 is coupled to a drive unit (not illustrated in fig. 1 for reasons of clarity) and is operatively connected to the supporting and driving means 3.

The car 1 and the counterweight 2 can be moved substantially along horizontally aligned guide rails by means of a rotational movement of the drive pulley 5.1, which transmits a drive torque of the drive unit to the supporting and driving means 3. For reasons of clarity, the guide rails are not illustrated in fig. 1. The car 1 and the counterweight 2 are guided on the guide rails by means of guide elements, such as, for example, guide shoes or guide pulleys.

The counterweight 2 is suspended here in a first loop of the supporting and driving means 3. The first loop is formed by a part of the supporting and driving means which is located between a first end 3.2 of the supporting and driving means 3 and a deflection pulley 5.2. The counterweight 2 is suspended from the first loop by means of a bearing 4.1. For this purpose, the counterweight 2 is coupled to the bearing 4.1. In the example shown, the bearing 4.1 constitutes the center of rotation of a counterweight supporting pulley 4. In this context, the supporting and/or driving means 3 runs from a first fixed point, to which the first end 3.2 of the supporting and/or driving means is attached, downward to the counterweight supporting pulley 4. The supporting and/or driving means 3 are wrapped around the counterweight supporting pulley 4 by approximately 180° and then extend upward up to the first deflection pulley 5.2.

The car 1 is suspended in a second loop of the supporting and/or driving means 3. The second loop is formed by part of the supporting and/or driving means which is located between a second end 3.1 of the supporting and/or driving means 3 and a second drive pulley 5.1. The car 1 is suspended from the second loop by means of two car supporting pulleys 7.1, 7.2. In this context, the supporting and/or driving means 3 runs from a second fixed point, to which the second end 3.1 of the supporting and/or driving means is attached, downward to a first car supporting pulley 7.1. The supporting and/or driving means 3 is wrapped around the first car supporting pulley 7.1 by approximately 90°, and then runs substantially horizontally to a second car supporting pulley 7.2 and is wrapped around the second car supporting pulley 7.2 by approximately 90°. Furthermore, the supporting and/or driving means 3 runs upward to the drive pulley 5.1. From the drive pulley 5.1 the supporting and/or driving means 3 finally runs to the first deflection pulley 5.2.

The two fixed points, to which the first and the second ends 3.2, 3.1 of the supporting and/or driving means 3 are attached, the deflection pulley 5.2, the drive pulley 5.1 and the guide rails of the car 1 and of the counterweight 2 are indirectly or directly coupled to a supporting structure, for example shaft walls.

The first end 3.2 of the supporting and/or driving means 3 is coupled to a sound receiver 8. The sound receiver 8 captures solid-borne sound which the supporting and/or driving means 3 transmits thereto.

In one alternative embodiment, the sound receiver is coupled to a guide rail of the counterweight 2. In this context, the sound receiver 8 captures solid-borne sound which the guide rail transmits to the sound receiver 8.

The solid-borne sound is produced by vibrations at elevator components during the operation of the elevator system 10. For example, vibrations occur as a result of the play between the guide elements of the car 1 or the guide elements of the counterweight 2 and the corresponding guide rails, as a result of the drive unit, as a result of the play in the bearings of the deflection pulley 5.2, drive pulley 5.1, cabin supporting pulleys 7.1, 7.2 and counterweight supporting pulley 4, as well as the vibrations of the supporting and/driving means 3 itself.

In particular, the bearing 4.1, from which the counterweight 2 is suspended, and guide elements, on which the counterweight 2 is guided on guide rails, generate vibrations which are in a characteristic frequency range and amplitude range. In the course of time, these elevator components are subject to wear phenomena which are reflected in a changed frequency range and amplitude range.

The sound receiver preferably captures solid-borne sound in a frequency range between 5 and 60000 Hz, in particular between 5 and 2500 Hz.

An evaluation circuit 9 is provided for evaluating the captured solid-borne sound. For this purpose, the evaluation circuit 9 is connected to the evaluation circuit 9 via a signal-transmitting link, typically a signal line. However, a person skilled in the art is aware of other means for transmitting signals, such as, for example, cableless signal-transmitting technologies which said person skilled in the art can readily apply here.

The sound receiver 8 transforms the captured solid-borne sound into a signal and transmits this signal to the evaluation circuit 9 via the signal-transmitting link. The evaluation circuit 9 has at least one processor and a memory unit. Signals which arrive from the sound receiver 8 are subjected to spectral analysis by the processor here, in

particular at the frequencies and amplitudes of the transmitted solid-borne sound. This spectral analysis gives rise to a frequency spectrum. The processor can then compare this frequency spectrum with one or more frequency spectrums stored in the memory unit.

The frequency spectrums which are stored on the memory unit correspond to different operating values. An operating value can constitute both a permissible operating value and a non-permissible operating value. Therefore, when the captured frequency spectrum is compared with the stored frequency spectrums, conclusions are drawn not only about compliance with a permissible operating value but also as to which mode of operation, which corresponds to a permissible operating value, is present, or, in the case of a non-permissible operating value being reached, even as to which type of operational fault has occurred. It is therefore possible, for example, to conclude whether the bearing 4.1 or a guide element is damaged.

If the transmitted frequency spectrum differs from a permissible operating value or if the transmitted frequency spectrum reaches a non-permissible operating value, a change-in-state alarm is preferably triggered by the evaluation circuit 9. The trigger of the change-in-state alarm at least causes the elevator system 10 to be made available for maintenance work in which the operational fault of the elevator system 10 is eliminated. For example, a service center is alerted which instructs a maintenance technician to perform maintenance on the respective elevator system 10. Alternatively, when a change-in-state alarm is triggered, the maintenance technician is informed directly to perform maintenance on the corresponding elevator system 10 via a mobile radio reception system which is connected to the elevator system.

The maintenance technician is preferably informed about the type of operational fault. In this context, the maintenance technician can obtain specific replacement material in order to repair the elevator system as quickly and efficiently as possible.

For safety reasons, the elevator system can also be deactivated when a change-in-state alarm occurs. In this case, a maintenance technician is also instructed to perform maintenance on the elevator system 10 and make it operational again.

CLAIMS:

1. An elevator system comprising:

a car,

a counterweight balancing out the car and

a supporting and/or driving means from which the car and the counterweight are suspended,

a sound receiver coupled to the elevator system configured to capture solid-borne sound which is generated at the counterweight, and an evaluation circuit connected to the sound receiver to evaluate the captured solid-borne sound,

wherein the sound receiver is coupled to a first end of the supporting and/or driving means, or the sound receiver is coupled to a guide plane of the counterweight.

2. The elevator system of claim 1, wherein the supporting and/or driving means forming a loop between a first ends of the supporting and/or driving means and a first deflection pulley, the counterweight is suspended in the loop by a bearing, wherein the sound receiver monitors the bearing.

3. The elevator system of claim 1, wherein the counterweight is guided by means of at least one guide element, on the guide plane, wherein the sound receiver monitors the at least one guide element.

4. The elevator system of claim 3, wherein the at least one guide element is a guide shoe or a guide pulley.

5. The elevator system of claim 3 or 4, wherein said guide plane is a guide rail or a guide cable.

6. The elevator system of claim 1, wherein the sound receiver is coupled to the first end of the supporting and/or driving means.

7. The elevator system of claim 1, wherein the sound receiver is coupled to the guide plane of the counterweight.

8. A method for operating an elevator system, said elevator system comprising:

a car,

a counterweight balancing out the car and

a supporting and/or driving means from which the car and the counterweight are suspended,

wherein solid-borne sound generated at the counterweight is captured by a sound receiver, which is coupled to the elevator system, and the solid-borne sound is evaluated by an evaluation circuit, which is connected to the sound receiver.

9. The method of claim 8, wherein the captured solid-borne sound is compared with an operating value by the evaluation circuit, and when an operational fault is detected, a change-in-state alarm is triggered by the evaluation circuit.

10. The method of claim 8, wherein the captured solid-borne sound is compared with a permissible operating value by the evaluation circuit, and when there is a deviation from the permissible operating value, a change-in-state alarm is triggered by the evaluation circuit.

11. The method of claim 8, wherein the captured solid-borne sound is compared with a non-permissible operating value by the evaluation circuit, and when the non-permissible operating value is reached, a change-in-state alarm is triggered by the evaluation circuit.

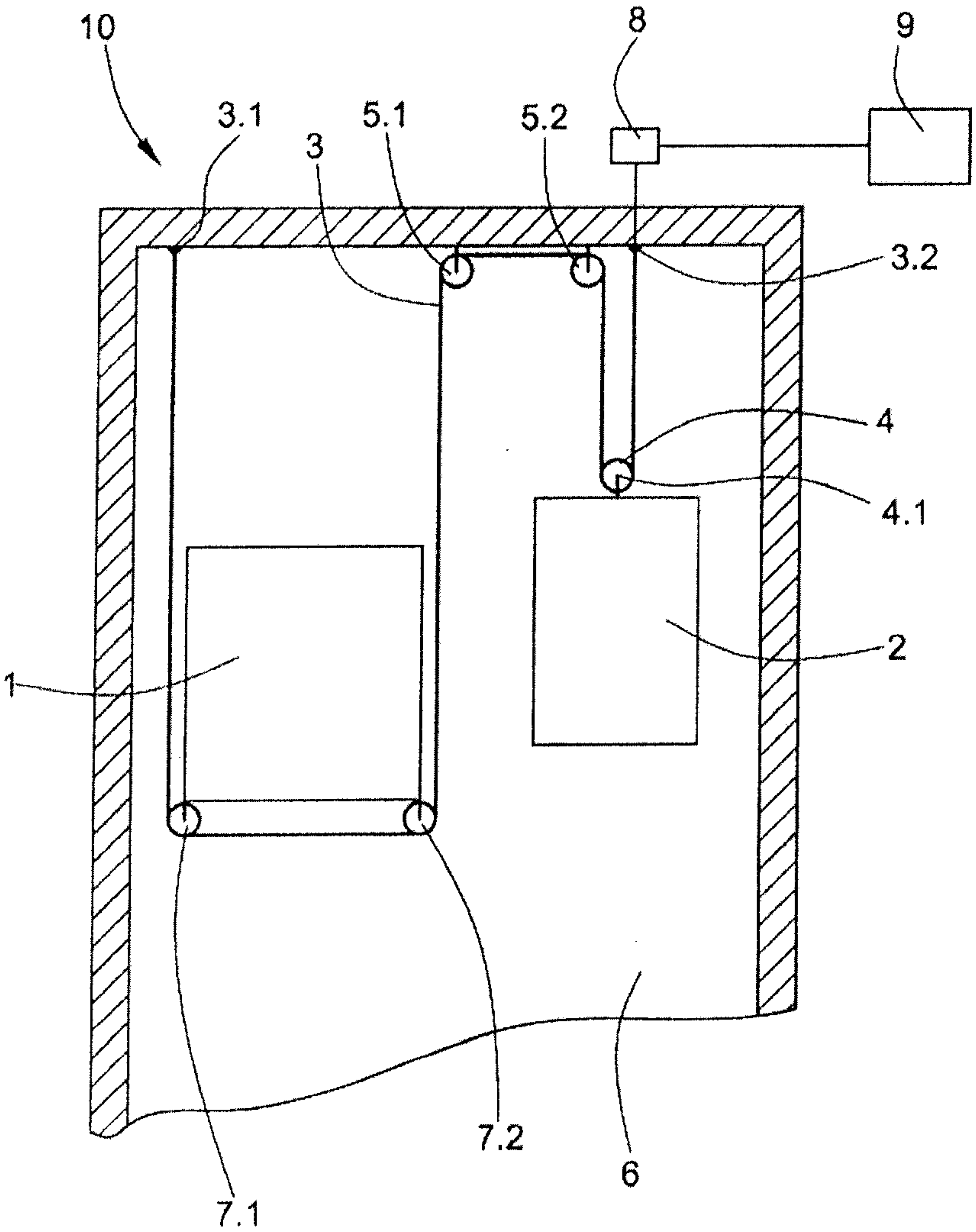
12. The method of any one of claims 9 to 11, wherein the captured solid-borne sound is caused by a damaged bearing, from which the counterweight is suspended on the supporting and/or driving means.

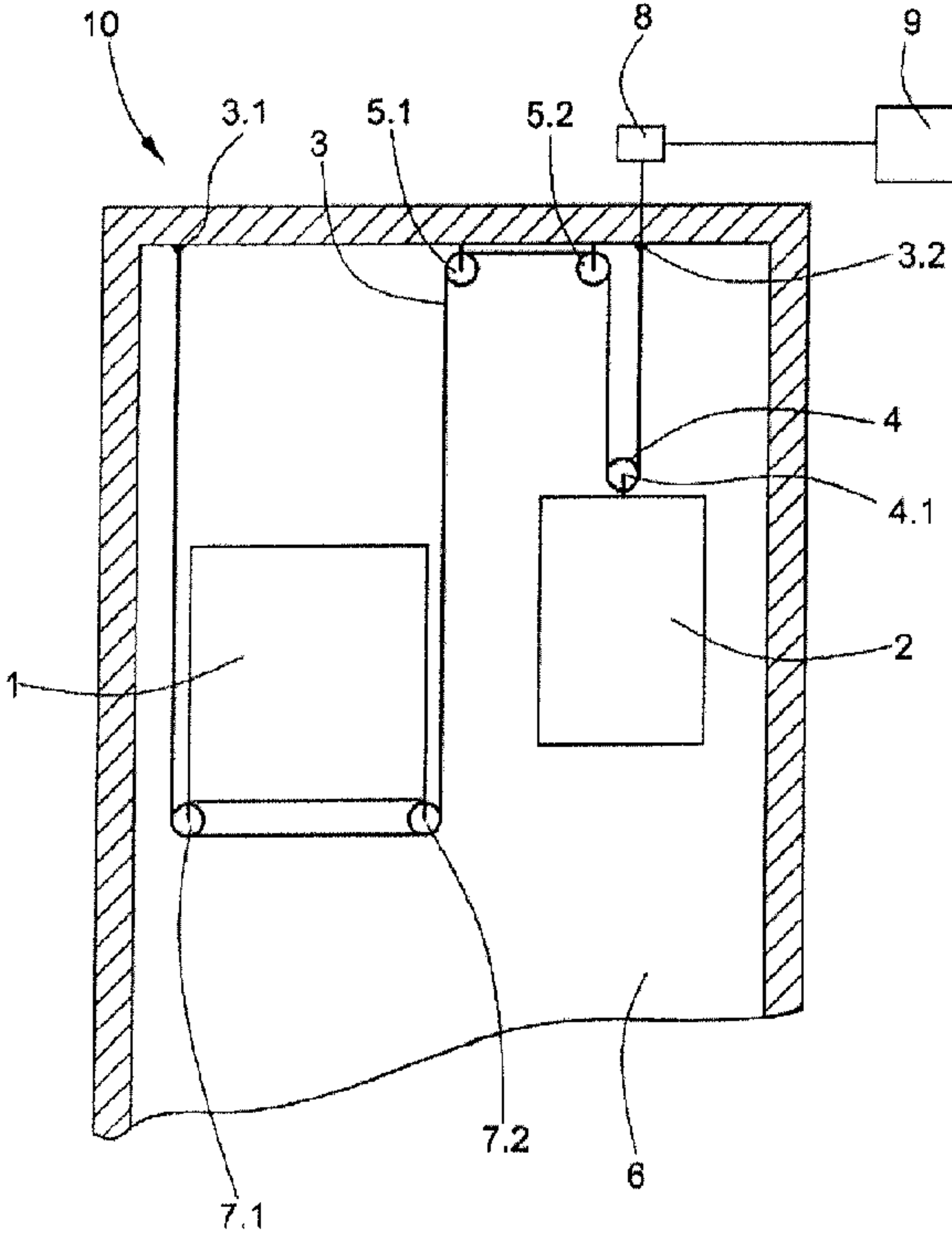
13. The method of any one of claims 9 to 11, wherein the captured solid-borne sound is caused by a damaged guide element which guides the counterweight on a guide plane.

14. The method of any one of claims 9 to 13, wherein the elevator system is made available for maintenance work when the change-in-state alarm is triggered.

15. The method of any one of claims 9 to 14, wherein the elevator system is deactivated when the change-in-state alarm is triggered.

Fig. 1

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