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(54) Title: METHOD OF IDENTIFYING POSITIONS OF BRAKE MONITORS

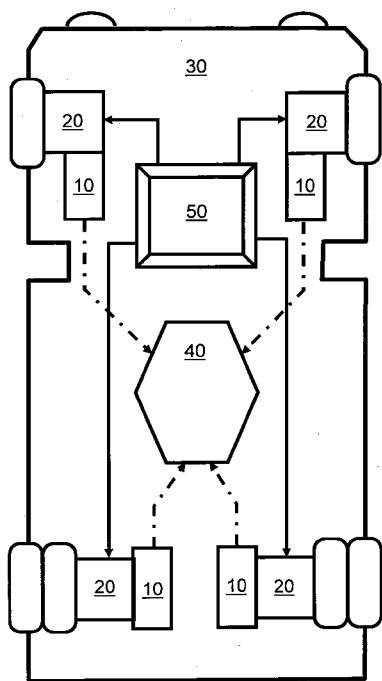


FIG. 1

(57) Abstract: There is described a method of identifying positions of brake monitors (10) in relation to wheel brake units (10) of a vehicle (30). The brake monitors (10) communicate by wireless to a control apparatus (40) of the vehicle (30). The method includes steps of: (a) installing the brake monitors (10) in association with the brake units (20); (b) individually or group-wise actuating the brake units (20) in a sequence whilst monitoring corresponding brake unit actuations by using the brake monitors (10) and generating corresponding brake unit actuation signals; (c) communicating the brake unit actuation signals from the brake monitors (10) to the control apparatus (40); and (d) receiving the brake unit actuation signals at the control apparatus (40), and identifying from the received brake unit actuation signals positions whereat the brake monitors (10) are installed on the vehicle (30). The method is of advantage in that sequential actuation of the brake units (20) and corresponding monitoring of associated signals generated by their brake monitors (10) is capable of enabling installation positions of the brake monitors (10) to be identified automatically.

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## METHOD OF IDENTIFYING POSITIONS OF BRAKE MONITORS

### Field of the invention

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The present invention relates to methods of identifying positions of brake monitors in relation to wheel brake units of vehicles. Moreover, the present invention also concerns brake monitoring systems operable to execute aforesaid methods. Furthermore, the present invention relates to software products recording on data carriers, wherein the software products are executable on computing hardware to implement aforesaid methods.

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### Background if the invention

15 Vehicle brakes are safety-critical components of vehicles, such that dangerous situations are susceptible to arising when vehicle brakes fail in operation. In consequence, it is known from a published international PCT patent application no. PCT/SE2006/000470 (WO 2006/112784 A1) to include monitoring devices within brake pads; the devices are operable to sense states of wear of the brake pads, and to communicate by wireless signals indicative of the states of wear. The wireless signals are receivable at control apparatus operable to generate driver information indicative of brake pad wear. When the brake pad wear approaches an unacceptable degree, the brake pads are beneficially replaced with new corresponding brake pads so that vehicle brake operation is more reliably ensured.

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25 However, inclusion of monitoring devices in brake pads as described in the foregoing suffers problems. A first problem is that brake pads are operable to dissipate in operation significant amounts of energy which results in the brake pads momentarily being heated to elevated temperatures of potentially several hundred degrees Centigrade. Such elevated temperatures are susceptible to exceeding a maximum operating temperature of semiconductor components, for example electronic integrated circuits and electro-chemical batteries, included in the monitoring devices. A second problem is that, after installation of brake pads including corresponding wireless monitoring devices onto wheel assemblies of a vehicle, the control apparatus requires programming regarding whereat the brake monitors are installed on the vehicle so that a wheel assembly corresponding to a worn brake pad can be subsequently identified for purposes of replacing the worn brake pad.

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The first and second problems have prevented such brake pads including monitoring devices embedded therein from finding general widespread use, despite brake pad wear continuing to be a major safety issue, especially for heavy road vehicles intended to haul freight containers and similar.

5 Use of other types of wireless monitoring devices is known from published patent specifications. For example, in a published United States patent no. US 5, 302, 939, there is described a dual tire equalizer having a remote indicator for a vehicle. The equalizer includes a diaphragm provided with an axial probe which is operable to selectively actuate a  
10 switch in a radio frequency transmitter circuit mounted on a wheel. The transmitter is operable to send a signal which varies in response to a condition of the switch. A radio frequency receiver on a vehicle and connected to an indicator in a driver's cab of the vehicle responds to the signal and issues appropriate information to the driver concerning condition of the equalizer.

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### Summary of the invention

An object of the present invention is to provide a method of identifying positions of brake  
20 monitors for rendering use of such brake monitors easier.

According to a first aspect of the invention, there is provided a method of identifying positions of brake monitors in relation to wheel brake units of a vehicle as defined in appended claim 1: there is provided a method of identifying positions of brake monitors in relation to wheel  
25 brake units of a vehicle, the brake monitors being operable to communicate by wireless to at least one control apparatus of the vehicle,

characterized in that the method includes steps of:

- (a) installing the brake monitors in association with the brake units;
- 30 (b) individually or group-wise actuating the brake units in a sequence whilst monitoring corresponding brake unit actuations by using the brake monitors and generating corresponding brake unit actuation signals;
- (c) communicating the brake unit actuation signals from the brake monitors to the at least one control apparatus; and
- 35 (d) receiving the brake unit actuation signals at the at least one control apparatus, and identifying from the received brake unit actuation signals positions whereat the brake monitors are installed on the vehicle.

The invention is of advantage in that sequential actuation of the brake units and corresponding monitoring of associated signals generated by their brake monitors is capable of enabling installation positions of the brake monitors to be identified automatically.

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Optionally, the method includes a step of providing each brake monitor with at least one identification code for use when communicating from the brake monitor to the at least one control apparatus, the at least one identification code enabling the brake monitor to be uniquely individually or group-wise identified by the at least one control apparatus when in communication therewith. Use of the identification code enables actuation signals subsequently generated by the brake monitor to be associated with a corresponding brake unit to which the brake monitor has been installed. Optionally, the brake monitors are uniquely identified in groups of brake monitors, for example pairs of brake monitors.

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Optionally, the method is implemented such that each brake monitor is operable to monitor movement of at least one brake block of its corresponding brake unit during actuation of the brake unit. The brake monitor is thereby potentially capable of not only sensing correct actuation but also a degree of wear which the brake block has undergone in operation.

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Optionally, the method is implemented such that the brake monitors are operable to function in a first hibernating state to conserve power, and a second active state for communicating an indication of actuation of their associated brake units, wherein switching between the first hibernating state and the second active state occurs for each brake monitor in association with actuation of its corresponding braking unit. Such operation of the brake monitors is of benefit when the brake monitors are powered from electrochemical batteries local thereto and also need to function from electrical energy supplied from the batteries for a period of many months or even several years.

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Optionally, the method is implemented such that the brake monitors are coupled to actuators of their corresponding brake units which are operable to apply associated brake blocks, the brake monitors being mounted at locations spaced apart from the brake blocks for reducing exposure of the brake monitors to heat generated in the brake blocks when in operation. Such mounting of the brake monitors assists to reduce exposure of the brake monitors to heat generated by the brake units when in operation to absorb kinetic energy of the vehicle.

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According to a second aspect of the invention, there is provided a brake monitoring system as claimed in appended claim 6: there is provided a brake monitoring system for a vehicle,

the system comprising at least one control apparatus and brake units which are susceptible to being individually or group-wise actuated in sequence, the system further comprising brake monitors coupled to the brake units for monitoring operation of the brake units, the brake units being coupled in communication with the at least one control apparatus of the system, wherein the system is operable to implement a method pursuant to the first aspect of the invention.

According to a third aspect of the invention, there is provided a software product stored on a data carrier as claimed in appended claim 7: there is provided a software product stored on a data carrier, the software product being executable on computing hardware for performing a method pursuant to the first aspect of the invention.

It will be appreciated that features of the invention are susceptible to being combined in any combination without departing from the scope of the invention as defined by the appended claims.

### **Description of the diagrams**

Embodiments of the invention will now be described, by way of example only, with reference to the following diagrams wherein:

Figure 1 is a schematic plan view of a vehicle including a plurality of brake units associated with wheels of the vehicle, the brake units being equipped with corresponding brake monitors operable to sense operation of their brake units, and at least one control apparatus operable to communicate with the brake monitors and thereby receive information indicative of actuation of the brake units;

Figure 2 is a schematic diagram of a brake monitor and its associated brake unit for use with the vehicle of Figure 1; and

Figure 3 is a flow chart including steps of a method of identifying positions of brake monitors in the vehicle of Figure 1.

## Description of embodiments of the invention

In overview, with reference to Figure 1, the present invention is concerned with a method of  
5 identifying positions of brake monitors **10** in relation to wheel brake units **20** of a vehicle **30**.  
The brake monitors **10** are operable to communicate by wireless to at least one control  
apparatus **40** of the vehicle **30**. Moreover, the method includes a first step of installing the  
brake monitors **10** in association with the brake units **20**. Additionally, the method includes a  
10 second step of individually or group-wise actuating the brake units **20** in a sequence whilst  
monitoring corresponding brake unit **20** actuations by using the brake monitors **10** and  
generating corresponding brake unit actuation signals. Furthermore, the method includes a  
third step of communicating the brake unit actuation signals from the brake monitors **10** to  
the at least one control apparatus **40**. Lastly, the method includes a fourth step of receiving  
15 the brake unit actuation signals at the at least one control apparatus **40**, and identifying from  
the received brake unit actuation signals positions whereat the brake monitors **10** are  
installed on the vehicle **30**.

The at least one control apparatus **40** is optionally a part of a safety system of the vehicle **30**.  
Alternatively, the at least one control apparatus **40** includes a data bus, for example  
20 implemented using a proprietary CAN bus as proposed by Philips NV in the Netherlands,  
through which diverse operating functions of the vehicle **30** are communicated in operation.

The present invention is, for example, relevant when the brake monitors **10** are being  
installed to the brake units **20**. Each brake monitor **10** is provided or allocated a reference  
25 identification code ID which the brake monitor **10** is operable to communicate to the at least  
one apparatus **40** by which the at least one apparatus **40** is able to uniquely identify each of  
the brake monitors **10**. Alternatively or additionally, the brake monitors **10** are susceptible to  
being identified in groups, for example in pairs, identification codes uniquely identifying such  
groups. Moreover, the brake units **20** are permanently coupled, namely hardwired, in  
30 communication with a braking system **50** of the vehicle **30** so that each brake unit **20**, or a  
group of brake units **20** such as a pair of brake units **20**, is capable of being specifically  
actuated. By sequentially actuating individual known brake units **20**, or groups of known  
brake units **20**, and recording which brake monitors **10** respond to such actuation together  
with corresponding reference codes ID's, the locations of the brake monitors **10** installed on  
35 the vehicle **30** can thereby be automatically determined.

Thus, when implementing the method, it is desirable that each brake monitor **10** is provided with at least one reference identification code ID for use when communicating from the brake monitor **10** to the at least one control apparatus **40**, wherein the at least one identification code enables the brake monitor **10** to be uniquely identified by the at least one control apparatus **40** when in communication therewith.

Referring to Figure 2, each brake monitor **10** is operable to monitor movement of at least one brake block **100** of its corresponding brake unit **20** during actuation of the brake unit **20**. The brake block **100** is actuated in operation towards a braking surface **110** which revolves together with a corresponding wheel **120** of the vehicle **30**. Each brake monitor **10** is optionally operable using a sensor **150** to sense a distance that its brake block **100** moves under actuation to provide a sensed indication of a degree of wear that the brake lock **100** has undergone. Such sensing using the sensor **150** is optionally achieved by using one or more of: a potentiometer, a magnetic proximity sensor, an electrostatic proximity sensor, an optical sensor, a capacitive sensor.

In order to reduce wiring complexity within the vehicle **30**, thereby potentially reduce its manufacturing cost and simplify its maintenance, the brake monitors **10** are beneficially energized by a source of power which is local thereto, for example the source of power being implemented as a battery of electrochemical cells denoted by **130**. However, it is not necessary for wheel monitoring purposes that the brake monitors **10** are continuously energized for sensing operation of their respective brake units **20**. Optionally, therefore, when implementing the method, the brake monitors **10** are operable to function in a first hibernating state to conserve power, and a second active state for communicating an indication of actuation of their associated brake units **20**, wherein switching between the first hibernating state and the second active state occurs for each brake monitor **10** in association with actuation of its corresponding braking unit **20**.

As described in the foregoing, it is beneficial that the brake monitors **10** are at least partially isolated and protected from heat generated by operation of their corresponding brake units **20**, for example from their one or more brake blocks **100**. Thus, optionally, the brake monitors **10** are coupled to actuators **140** of their corresponding brake units **20** which are operable to apply associated one or more brake blocks **100**, wherein the brake monitors **10** are mounted at locations spaced apart from the brake blocks **100** for reducing exposure of the brake monitors **10** to heat generated in the brake blocks **100** when in operation.

When the brake monitors **10** are installed in groups, for example in pairs, and mounting positions of the groups of brake monitors **10** only need to be identified pursuant to the present invention to a resolution of the groups, such that the brake monitors **10** are actuated in groups and their corresponding actuation sensing responses then recorded at the at least one apparatus **40** for identifying which groups of brake units **20** with which the group of brake monitors **10** are associated.

The at least one control apparatus **40** and the brake units **20** together with their brake monitors **10** are beneficially considered to comprise a brake monitoring system. The at least one control apparatus **40** and the brake units **20** of the system are susceptible to being individually or group-wise actuated in sequence, and the system beneficially further comprises the brake monitors **10** coupled to the brake units **20** for monitoring operation of the brake units **20**; the brake units **20** are coupled in communication with the at least one control apparatus **40** of the system, and the system is operable to implement the aforementioned method.

The method is beneficially implemented using one or more software products executable on computing hardware included at one or more of the brake monitors **10** and the at least one control apparatus **40**. The one or more software products are susceptible to being conveyed on a data carrier, for example via a signal, a solid state memory, an optical memory medium to mention a few implementations. For example, each brake monitor **10** is provided with an associated computing device **160** for directing sensing operations, sensed actuation signal conditioning and protocols for wireless communication with the at least one control apparatus **40**.

Steps of the aforementioned method are shown in Figure 3. The first step of installing the brake monitors **10** in association with the brake units **20** is denoted by **200**. Additionally, the second step of individually or group-wise actuating the brake units **20** in a sequence whilst monitoring corresponding brake unit **20** actuations by using the brake monitors **20** and generating corresponding brake unit actuation signals is denoted by **210**. Furthermore, the third step of communicating the brake unit actuation signals from the brake monitors **20** to the at least one control apparatus **40** is denoted by **220**. Lastly, the fourth step of receiving the brake unit actuation signals at the at least one control apparatus **40**, and identifying from the received brake unit actuation signals positions whereat the brake monitors **10** are installed on the vehicle **30** is denoted by **230**.

Although wireless communication between the brake monitors **10** and the at least one control apparatus **40**, for example via Bluetooth or similar wireless protocol, is employed, alternative communication routes are alternatively or additionally employed. Such alternative communication routes optionally include one or more of: optical communication, acoustic communication, hardwired connection.

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The at least one control apparatus **40** is beneficially implemented as an arrangements of one or more monitoring apparatus, for example implemented as a brake integrity monitoring system or apparatus.

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Expressions such as "has", "is", "include", "comprise", "consist of", "incorporates" are to be construed to include additional components or items which are not specifically defined; namely, such terms are to be construed in a non-exclusive manner. Moreover, reference to the singular is also to be construed to also include the plural. Furthermore, numerals and other symbols included within parentheses in the accompanying claims are not to be construed to influence interpreted claim scope but merely assist in understanding the present invention when studying the claims.

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Modifications to embodiments of the invention described in the foregoing are susceptible to being implemented without departing from the scope of the invention as defined by the appended claims.

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**CLAIMS**

1. A method of identifying positions of brake monitors in relation to wheel brake units of a vehicle, said brake monitors being operable to communicate by wireless to at least one control apparatus of the vehicle,
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- characterized in that said method includes steps of:
- (a) installing said brake monitors in association with said brake units;
  - (b) individually or group-wise actuating said brake units in a sequence whilst monitoring corresponding brake unit actuations by using said brake monitors and generating corresponding brake unit actuation signals;
  - (c) communicating said brake unit actuation signals from said brake monitors to said at least one control apparatus; and
  - (d) receiving said brake unit actuation signals at said at least one control apparatus, and identifying from said received brake unit actuation signals positions whereat said brake monitors are installed on said vehicle.
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- 15
2. A method as claimed in claim 1, wherein said method includes a step of providing each brake monitor with at least one identification code for use when communicating from said brake monitor to said at least one control apparatus, said at least one identification code enabling said brake monitor to be uniquely individually or group-wise identified by said at least one control apparatus when in communication therewith.
- 20
3. A method as claimed in claim 1 or 2, wherein each brake monitor is operable to monitor movement of at least one brake block of its corresponding brake unit during actuation of the brake unit.
- 25
4. A method as claimed in claim 1, 2 or 3, wherein said brake monitors are operable to function in a first hibernating state to conserve power, and a second active state for communicating an indication of actuation of their associated brake units, wherein switching between said first hibernating state and said second active state occurs for each brake monitor in association with actuation of its corresponding braking unit.
- 30
5. A method as claimed in any one of the preceding claims, wherein said brake monitors are coupled to actuators of their corresponding brake units which are operable to apply associated brake blocks, said brake monitors being mounted at locations spaced apart from
- 35

said brake blocks for reducing exposure of said brake monitors to heat generated in said brake blocks when in operation.

6. A brake monitoring system for a vehicle, said system comprising at least one control  
5 apparatus and brake units which are susceptible to being individually or group-wise actuated  
in sequence, said system further comprising brake monitors coupled to said brake units for  
monitoring operation of said brake units, said brake units being coupled in communication  
with said at least one control apparatus of said system, wherein said system is operable to  
implement a method as claimed in any one of the preceding claims.

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7. A software product stored on a data carrier, said software product being executable  
on computing hardware for performing a method as claimed in any one of claims 1 to 5.

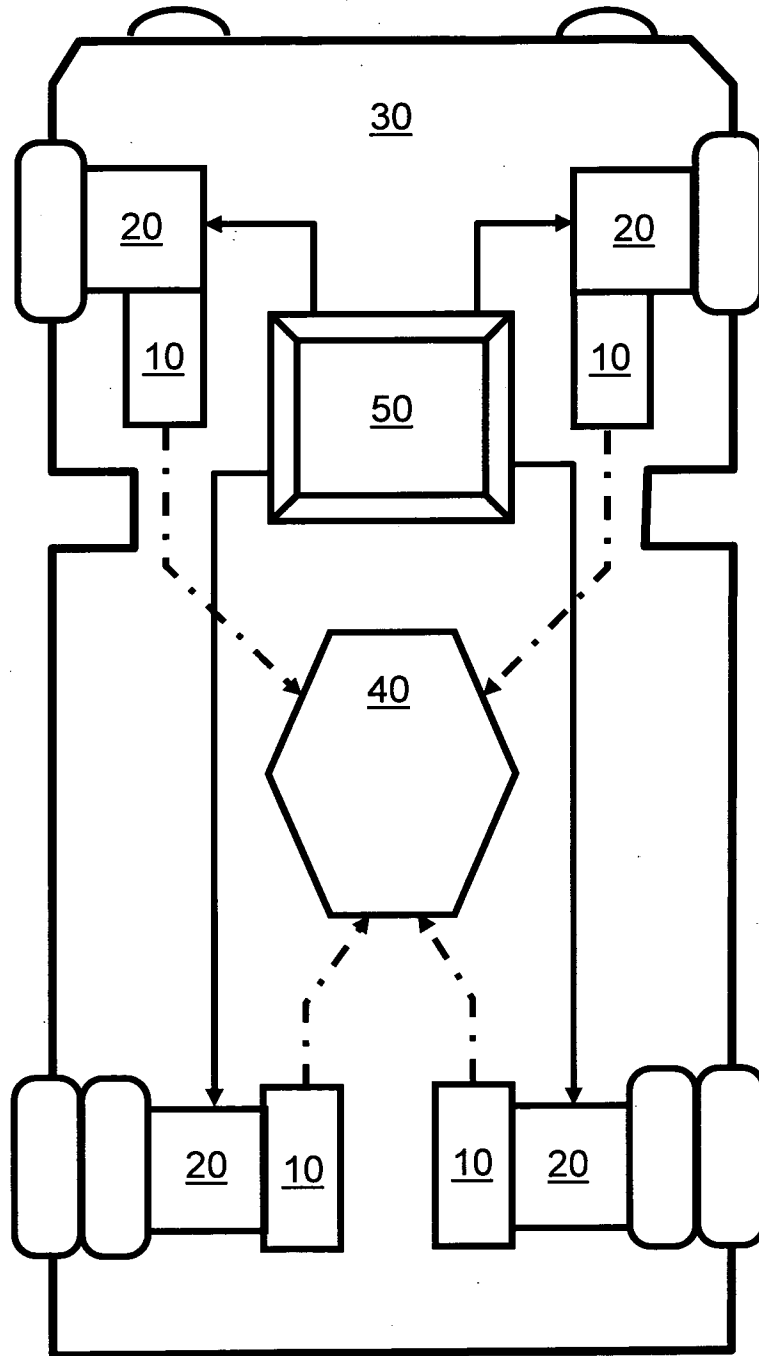


FIG. 1

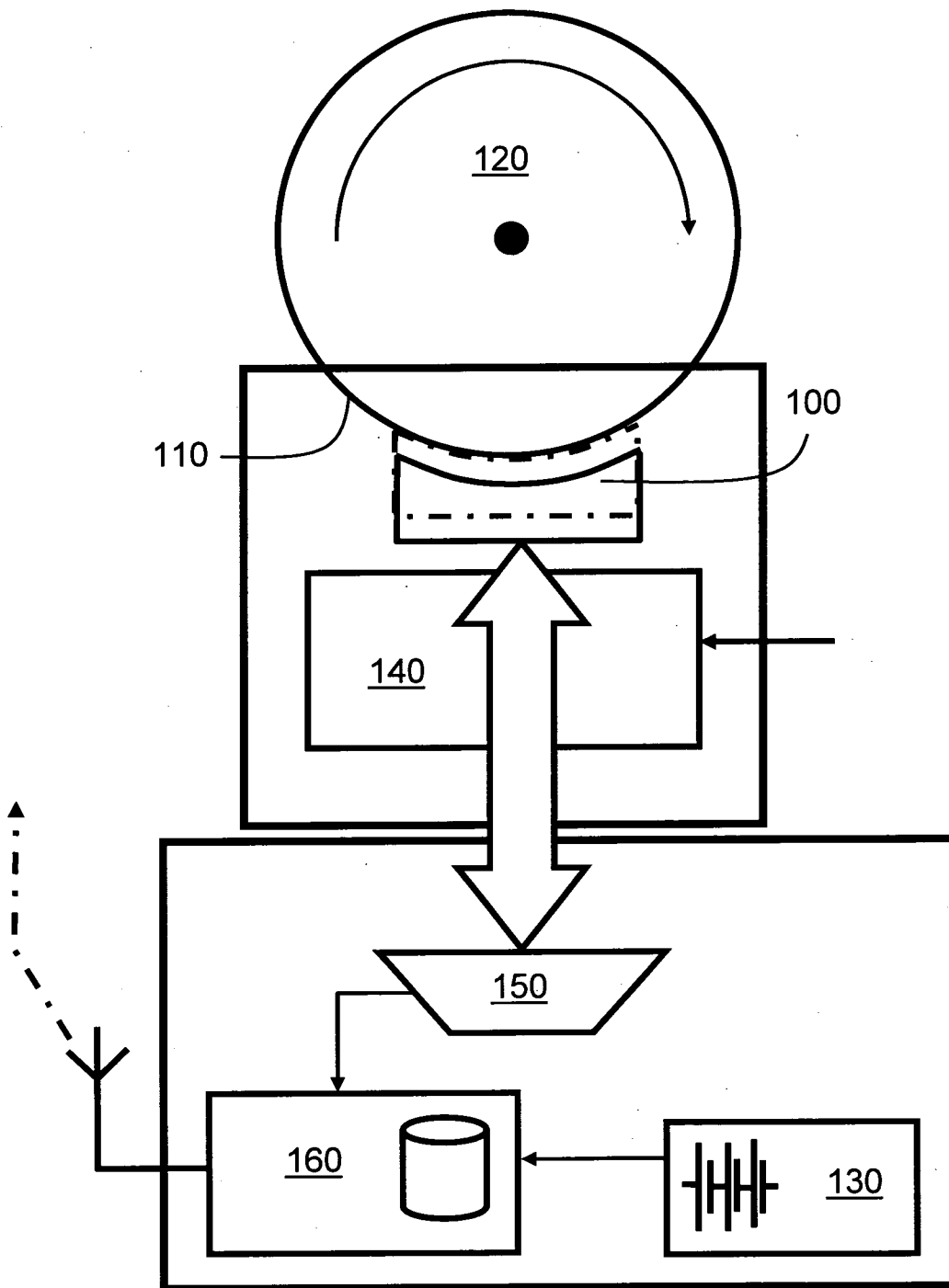


FIG. 2

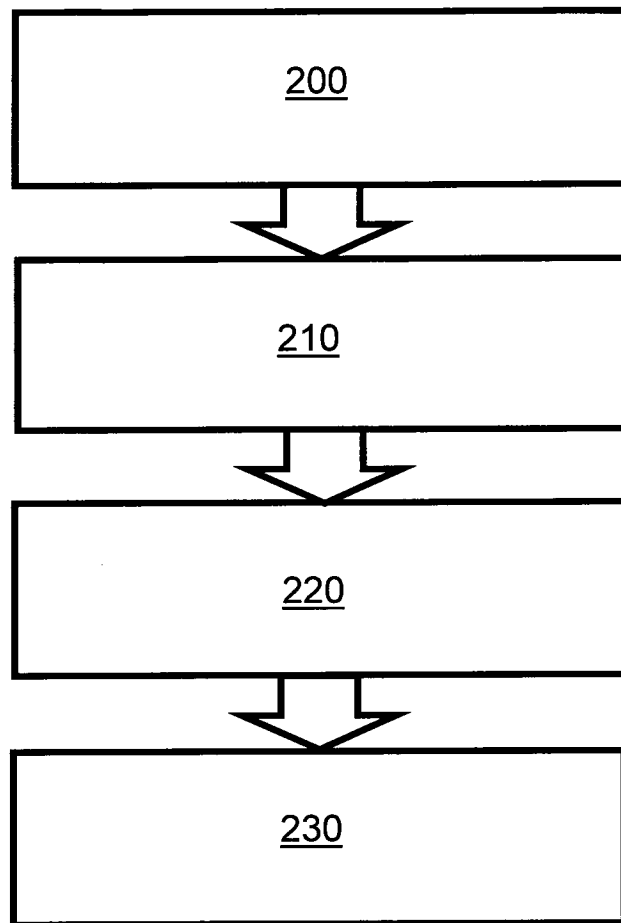


FIG. 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2008/000261

A. CLASSIFICATION OF SUBJECT MATTER		
<b>IPC: see extra sheet</b> According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
<b>IPC: F16D, B60T, B60C</b>		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
<b>SE,DK,FI,NO classes as above</b>		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>EPO-INTERNAL, WPI DATA, PAJ</b>		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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Date of the actual completion of the international search		Date of mailing of the international search report
19 November 2008		21-11-2008
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer  Karl Persson / JA A Telephone No. +46 8 782 25 00

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International application No.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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*F16D 66/02* (2006.01)

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*F16D 66/00* (2006.01)

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Cited literature, if any, will be enclosed in paper form.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

01/11/2008

PCT/SE2008/000261

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