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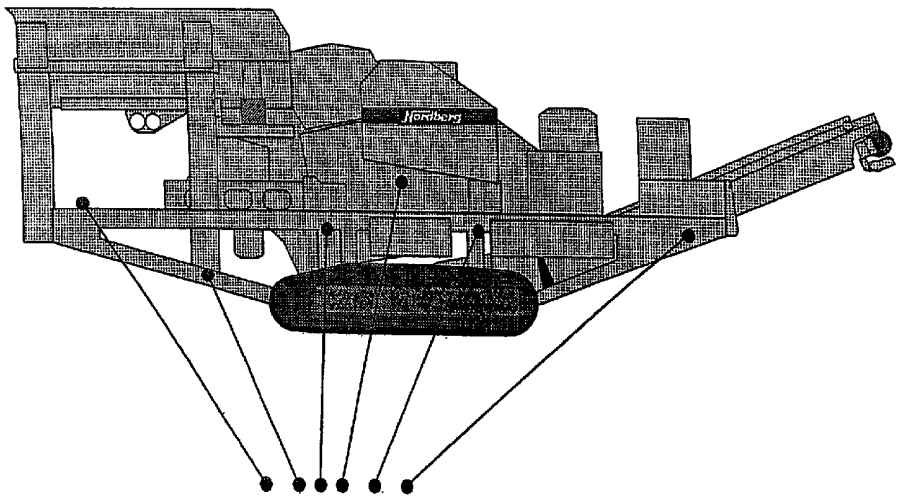
(54) Title: SYSTEM FOR COLLECTING INFORMATION



Placement of the sensors

(57) Abstract: In this method, operational information from a mineral material processing unit is collected, the information is processed, and it is presented in a form suitable in optimising usage, in equipment development work, or for added value service for client. Collected and/or pre-processed data can be transmitted further by radio, e.g. using cellular phone network, and data from numerous crusher units can be collected in a centralized server. The data about operation is acquired by i.e. measuring the unit's strain by e.g. strain gauges or acceleration sensors. The object of this invention is also a processing unit for applying the method, and a system that includes components necessary for the method.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

SYSTEM FOR COLLECTING INFORMATION

The object of this invention is a method for collecting information from a processing unit for mineral material, usable for development work, optimisation of operation, or providing added value service for the client, and a processing unit equipped with means for collecting information. The invention also concerns a system including said units, in which system the method in accordance with the invention is applied.

Background art

The collection of different types of information has become easier due to the development of digital technology. Due the increase of mass memory capacity and calculation efficiency, single measurements can advantageously be saved in great numbers, and processed with microprocessors continuously or after collection. Depending on the method of analysis, the amount of data so produced can be used to create many different kinds of ratios, curves, or reports representing the monitored event in question.

In the handling of mineral materials, optimisation of time and equipment capacity usage are naturally also desirable. Thereby it can be useful to monitor the performance of the equipment during operation and to collect information for analysis.

Disclosure of the Invention

In a method in accordance with the present invention, defined in claim 1, operational information from a mineral material processing unit is collected, the information is processed, and it is presented in a form suitable in optimising usage, in equipment development work, or for added value service for the client. The object of this invention is also a processing unit in accordance with claim 6 for applying the method, as well as a system in accordance with claim 11.

A mineral material processing unit in this context is a unit, the task of which is further refinement of mineral material, such as broken rocks (blast stones), gravel, crushed stone, concrete, and other stone based materials, for example in screening or crushing. The apparatus in this case includes at least one crusher or screen. The crushing unit in this

context is an apparatus assembly that includes, mounted in framework, at least a crusher, a power source, transmission equipment, and a possible feeding device and means for transporting the crushed stone material out of the unit. The unit can include classification equipment such as screen or grizzly units for separation of different product fractions. The crusher can be, for example, a cone crusher, a gyratory crusher, a jaw crusher or an impact crusher. The crushing unit can be permanently mounted or mobile, i.e. provided with caterpillar tracks.

The screening unit can be, for example, a pre-screening unit equipped with a grizzly for coarse material screening, or a screen cloth grader unit for further refining.

The operation of the mineral material processing unit can be monitored by collecting information from, for example, the operational status of its components, movements, distance between parts, shape changes in the equipment, accelerations and velocities occurring within the equipment, acoustic emissions, the shape of bearings, performance of the power source, power usage, temperatures, and unit location and position.
Sensor information is advantageously collected at high frequency and collected data is stored and/or pre-processed at the processing unit, or within apparatus connected to it, locally before it is transmitted to a server or other similar apparatus external to the processing unit, in which apparatus data from one or more processing units is collected.
Collected and/or pre-processed data can be transmitted further by radio, advantageously using cellular or satellite telephone networks.

The collection of information is done in a known manner using sensors connected to I/O-units as required, which units transform information from sensors into a form required by the information collecting and processing unit. Numerous I/O-units and sensors suitable for this purpose are available on the market for selection by a person skilled in the art. Usable sensors are i.e. strain gauges, pressure cells, acceleration sensors, rotational speed sensors, acoustic emission sensors, inclination sensors, power transformers, ultrasound probes, and temperature sensors.

Strain gauges can be used to measure e.g. shape shifts within the unit's framework, data can be collected over an extended period of time, and this data can be used to create a load spectrum.

Accelerations sensors can be used e.g. to monitor the situation when stone material is fed into the processing unit by a shovel loader. The effects of a momentary impact load during the feeding event can be monitored in relation to one, two, or three axis, and the distance between feeder bottom and the frame of the processing unit can be measured using an ultrasound probe. Inclination sensors can be used to measure inclination angles of the unit. An user load index can be calculated based on the results, which index represents the load on the processing unit due to user activity.

Further, the operational condition of the sliding bearings in the crushing unit can be monitored in the manner described in Finnish patent application 20010599. E.g. measurement of friction forces carried out with strain gauges provides information about the bearing wear rate, and a preventive maintenance program can be planned.

Detailed Description of the Invention

The invention is described in detail in the following using a rock crushing unit as an example. Reference is made to the enclosed drawings, wherein

Figure 1 is a side view of a movable rock crushing unit, feeder and crusher parts being shown as sections,

Figure 2 shows an embodiment in accordance with invention for monitoring feeder load,

Figure 3 is an example of processing information collected with sensors in accordance with Figure 2,

Figures 4 and 5 show an application in accordance with invention for continuous monitoring of the load on a crusher frame, as well as pre-processing of measurement data.

The rock crushing unit, which in figure 1 is a mobile unit, includes frame 1, feeder 2, jaw crusher 3, power source 4, and conveyer 5 for crushed material. Fine-grained material separated in the feeder exits on transversal conveyer 6.

Figure 2 shows the location of sensors in the feeder unit in accordance with the invention. Accelerations occurring within the feeder during material input are observed with acceleration sensor 7. The distance between feeder and frame is measured by ultrasound sensor 8, from which distance the amount of material in the feeder can be derived. Accelerations in the z-direction of the frame during feeding are observed with acceleration sensor 9, and accelerations in the y-direction of the frame during feeding are respectively observed with acceleration sensor 10. Inclination angles of the crushing unit in the x- and y-directions are measured by inclination sensor 11.

The I/O-units can include processing and storage elements for sensor messages, and elements for data transfer.

The sensor messages are transformed in the I/O-unit into digital form in a manner known to those skilled in the art, and carried by radio or cable to a data collection and processing unit located in or in close proximity to the crushing unit.

Figure 3 illustrates an example of how a quantity describing feeder load can be derived from the sensor data in accordance with figure 2. The number of times a defined limits is exceeded per unit time is counted, this number is weighted by a defined coefficient, and the load index is obtained from the sum of these products. The time integral, for example, can also be obtained from this calculated quantity.

An example of the location of strain gauges in the frame of a crushing unit is illustrated in figure 4. The measurement can be made for example at 1000 Hz frequency. Figure 5 illustrates system's structure. The message moves from gauges 12 to A/D-converter 13, and is transferred to measuring bus 14 after conversion. The measuring bus transmits the data to microprocessor based apparatus 15, which processes data continuously with methods known to those skilled in the art, and transmits pre-processed data to a information collection and processing unit, or transmits the data as such to the information collection and processing unit. Microprocessor based apparatus 15 can be configured to transmit data from the measurement bus straight to the information collection and processing unit, or to perform different kinds of data pre-processing. These methods known to those skilled in the art are i.e. Rainflow calculation, calculation of Markov-matrix, and Peak-Valley calculation. In the case where the data is transmitted

from the measuring bus straight to the information collection and processing unit, the data can likewise be processed with the methods mentioned here. Apparatus 15 transmits data at configurable time intervals (for example, 10 s) through data bus 16 to the information collection device that collects, processes, and stores data from different sources.

The application illustrated in figure 5 represents an example describing present strain gauge measurement, but the physical separation of sensors, transformer, buses, and collection and processing units can vary in a system in accordance with the invention. For example, some or even all of the previously mentioned components can be integrated into a so-called intelligent sensor.

A similar continuous measurement can be applied when monitoring other operational components of the crusher unit, e.g. the crusher.

The data collection apparatus is preferably equipped with transmitter devices for wireless data transfer, preferably for example a mobile telephone transmitter (GSM, GPRS, UMTS, Bluetooth or similar), in which processed or packed information can be transmitted to a remote server. The transmission can naturally take place by means of other conventional, advantageous wired data transfer devices if there are no suitable connections, or with physical memory devices. Data from numerous other crushing units can then be collected in a server or other similar centralized apparatus, and processed further. Processing units can be equipped with satellite localizing devices, or other localizing and/or identification devices.

From the information collected and processed in the server, a database can be built and the data can be utilized by, on the one hand, the users of the processing unit, and on the other hand development and marketing personnel, and the data can be provided to a client as added value service. Based on cumulative load data, location data, and production efficiency figures, e.g. kWh/t, the need for replacement of wear parts can be predicted, and maintenance schedules drawn up.

Claims

1. A method for collecting operational data from mechanical equipment by means of an information collection and processing unit, signal converters, sensors, and analogical connections and digital buses connecting these, **characterized** in that the measurement information is collected from a mineral material processing unit.

2. A method in accordance with claim 1, **characterized** in that the measurement information is processed using a unit having memory and processing capacity and being located in, or in connection with the mineral material processing unit, before the information is transmitted to data storage and/or processing devices located externally to the mineral material processing unit.

3. A method in accordance with claim 2, **characterized** in that the processed measurement information is load information retrieved from the mineral material processing unit by strain gauge measurement.

4. A method in accordance with claim 2, **characterized** in that the feeder load in the mineral material processing unit is measured.

5. A method in accordance with any of the claims 1-4, **characterized** in that the transfer to external data storage and processing devices is carried out by means of a telephone network, a mobile telephone network, or a satellite telephone network.

6. A mineral material processing unit, **characterized** in that it includes at least one sensor for measuring at least one physical parameter from the unit, means for transmitting sensor signals and converting them into digital form, means for transmitting and processing digital signals, and means for storing processed information and transmitting it outside of the unit.

7. A mineral material processing unit in accordance with claim 6, **characterized** in that the sensors are acceleration sensors, strain gauges, pressure cells, rotational speed sensors, acoustic emission sensors, inclination sensors, power transformers, ultrasound sensors, or temperature sensors.

8. A mineral material processing unit in accordance with claim 6, **characterized** in that the processed information is transmitted outside of the unit using wireless data transfer.

9. A mineral material processing unit in accordance with claim 8, **characterized** in that the data transfer in made by cellular telephone or satellite telephone connection.

10. A mineral material processing unit in accordance with claim 6, **characterized** in that it additionally includes a satellite localizing device.

11. A system for collecting and processing operational information, **characterized** in that a method in accordance with claim 1 is applied, and the system includes at least one processing unit, and information storage and processing devices located externally to the processing units in accordance with claim 6.

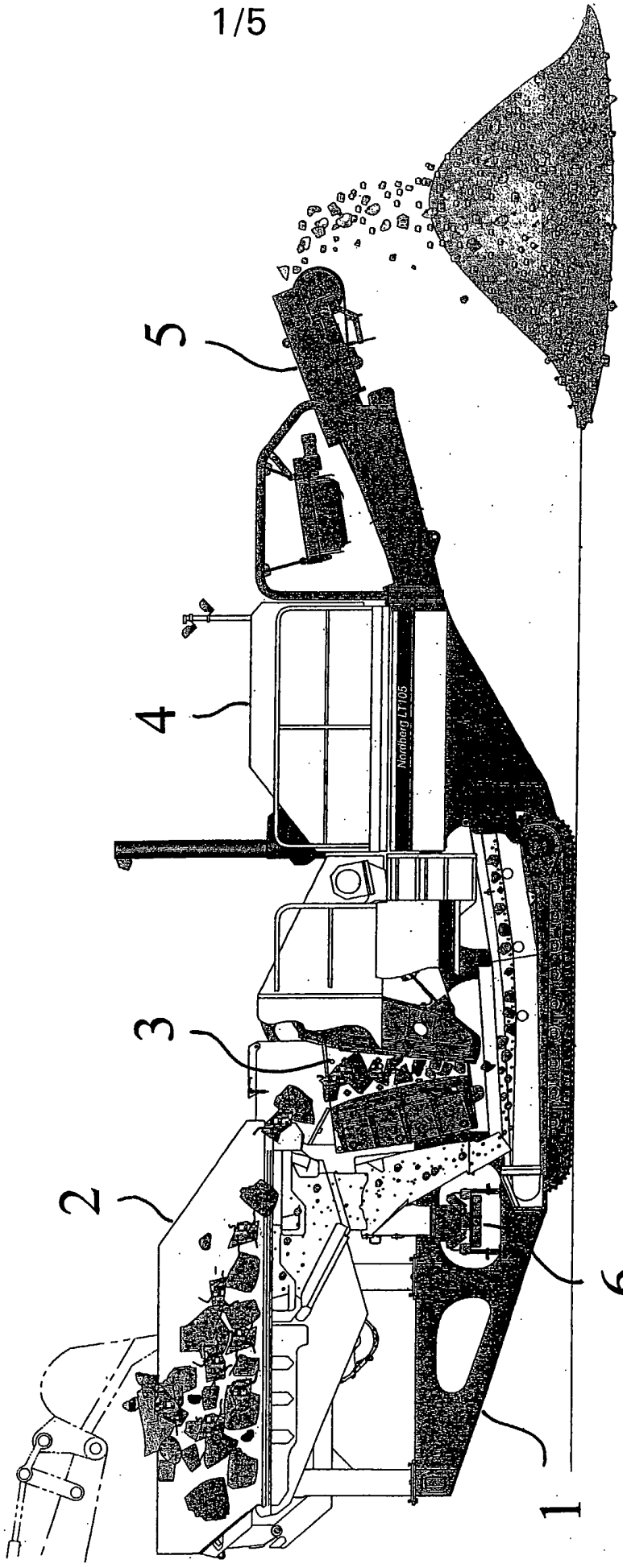


Fig. 1

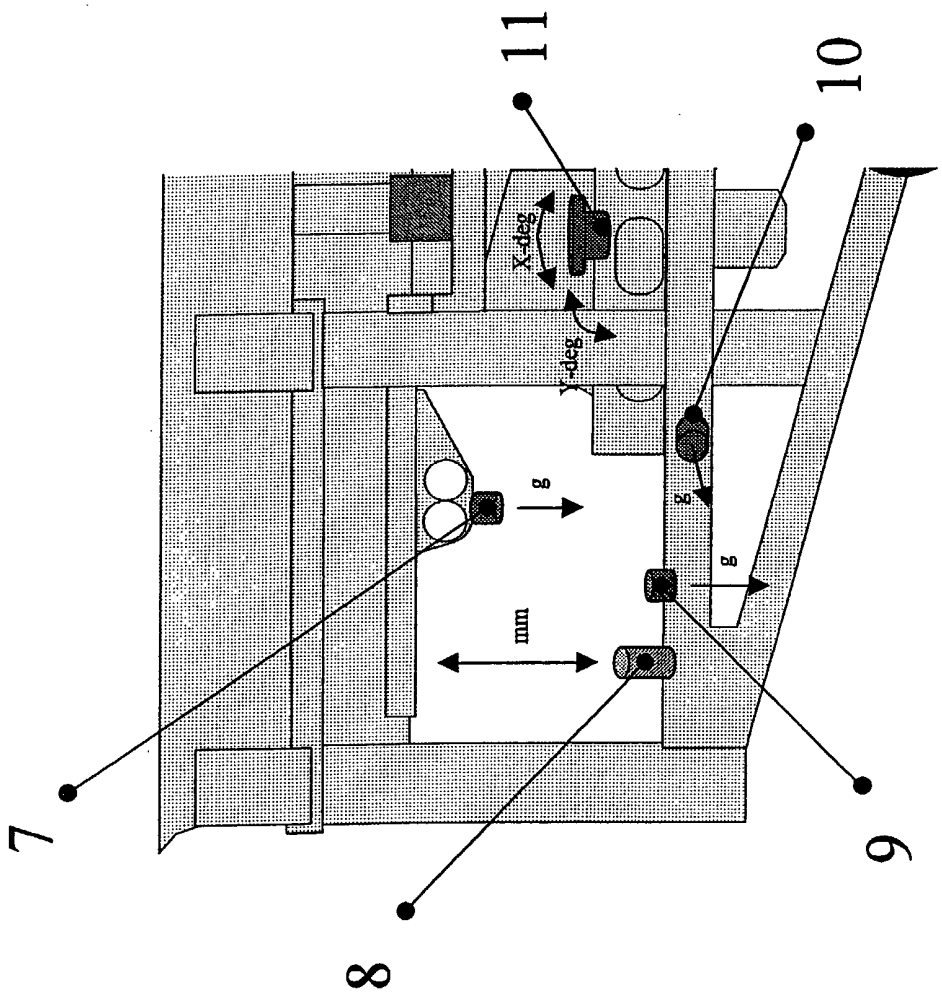
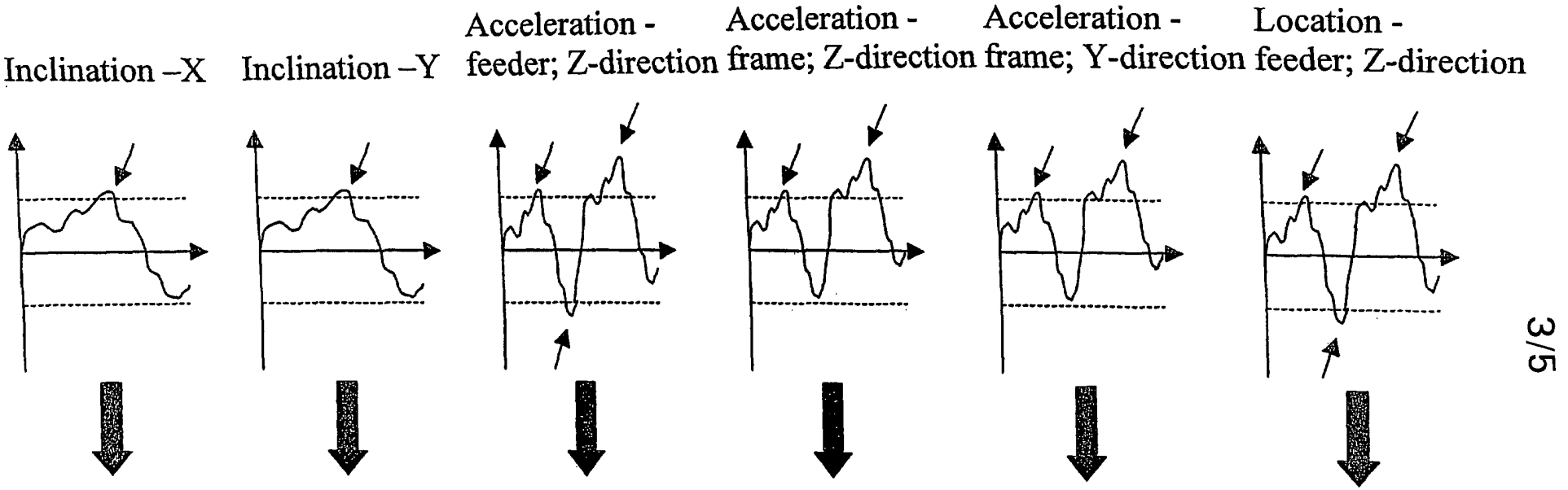


FIG. 2



$$\text{User load index} = (a*K + b*J + c*L + d*M + e*N + f*P) / t$$

FIG. 3

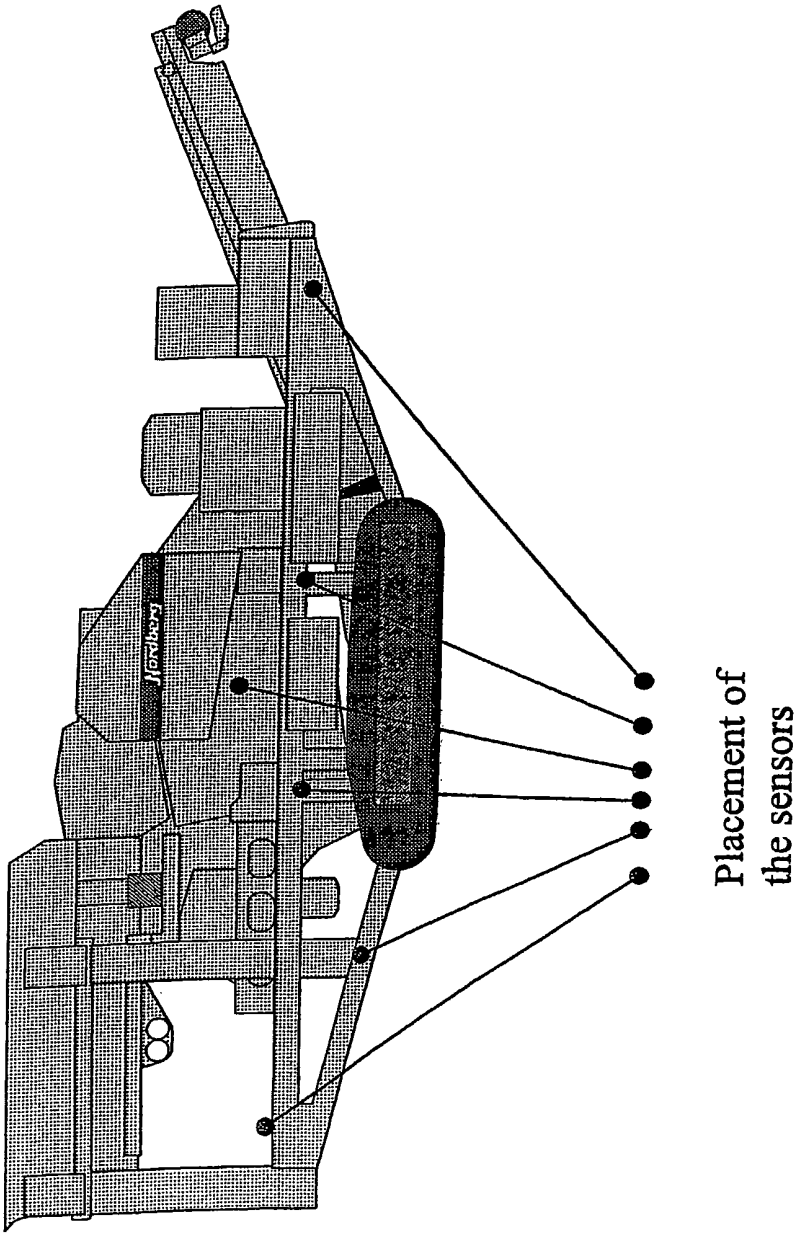
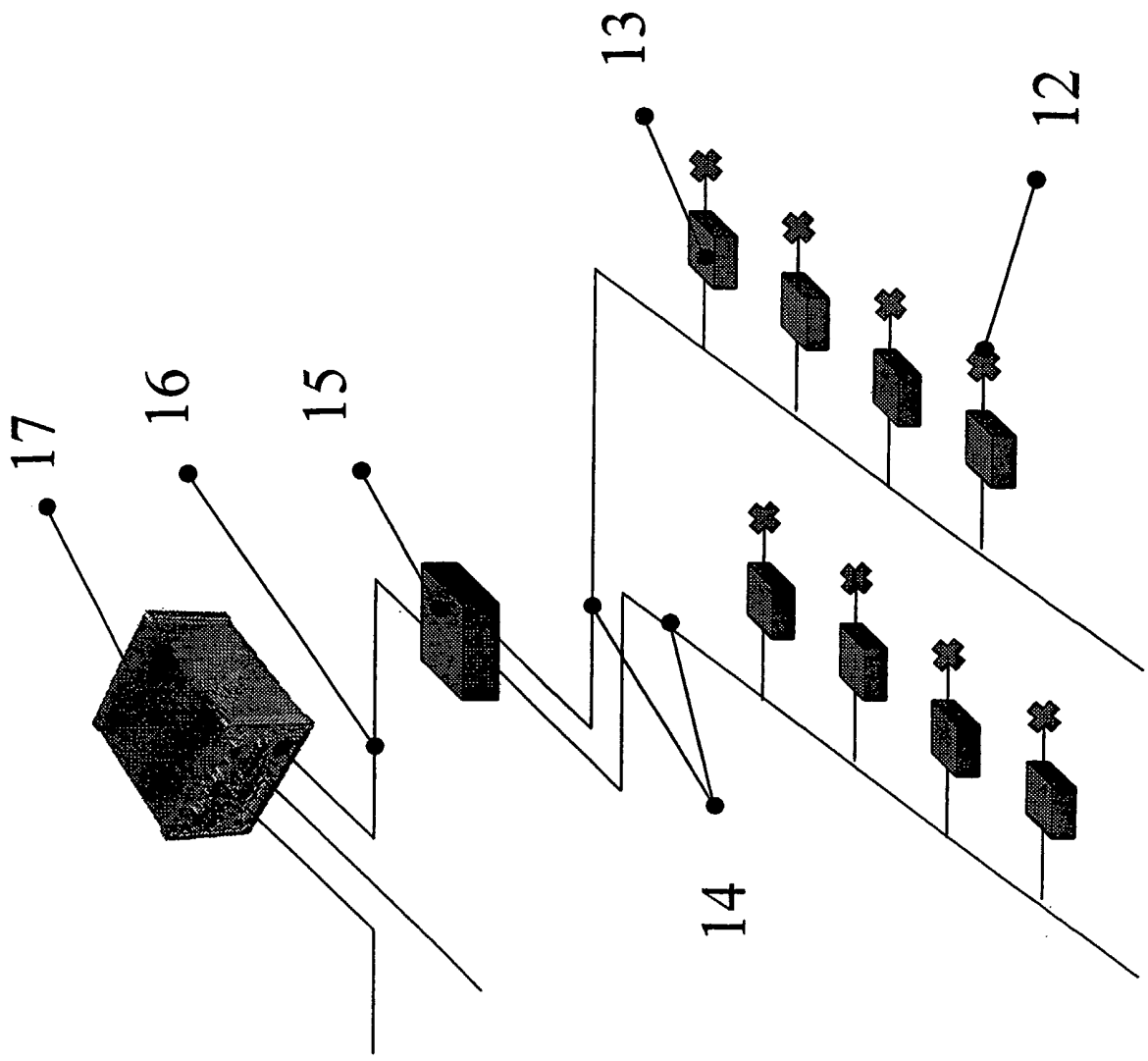


FIG.4

FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00197

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G06F 17/40, B02C 4/00
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)

IPC7: G06F, B02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5203188 A (PETER N. OSGOOD ET AL), 20 April 1993 (20.04.93) --	1-11
X	GB 2347569 A (NABILA LIMITED), 6 Sept 2000 (06.09.00) --	1-11
X	US 5182449 A (ALLAN H. JOHNSON ET AL), 26 January 1993 (26.01.93) -- --------	1-11

☐ Further documents are listed in the continuation of Box C. ☒ 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
24 June 2002	08-07-2002
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INTERNATIONAL SEARCH REPORT

Information on patent family members

01/05/02

International application No.
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US 5203188 A	20/04/93	NONE	
GB 2347569 A	06/09/00	GB 9905477 D	00/00/00
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