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CONTROL AND POSITIONING SYSTEM FOR THE EXCHANGE OF WEAR LINING ELEMENTS ON A WALL SUBJECT TO WEAR

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(56) Related Art
US 2011/0134225 A1
US 5978094 A
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20152010044 27 Feb 2015

ABSTRACT

The invention concerns a control and positioning system for the indication of the mounting position of an exchangeable wear lining element (10) at a surface at a wall (2) that is subject to wear, which may be constituted by, for example, the inner surface of a rotating drum (1) at an ore grinder, and where the wear lining element is supported at the free end of a manoeuvrable arm that is a component of a lifting arrangement (14) that is controlled during the handling of the wear lining element during a mounting operation by a crane operator (5), whereby the wall is provided with a set of mounting holes (21) and the wear lining element is equipped on its lower surface with a set of attachment means (17), whereby the wear lining element is intended to be tightened against the surface by means of supplementary attachment means (17') that are introduced through the mounting holes. The system comprises, for efficient and safe mounting: a first reference system (Rv) formed by the mounting holes (21) of the wall (2), a second reference system (Rs) formed by the attachment means (17) located on the lower surface of the wear lining element (10), a two-dimensional sensor (31, 31') that is arranged to be stationary at the outer surface of the wall (2), i.e. on the opposite side of the wall of the mounting surface to that which is exposed to wear, in such a manner that the field of view of the sensor contains the lower surface of the wear lining element (10) viewed through the mounting holes (21), whereby the sensor is arranged to transmit an electrical signal that represents an image of the relative position between the two reference systems (Rv, Rs), and with the guidance of which image the mounting position of the wear lining element (10) at the wall can be determined by the crane operator (5).

20152010044 27 Feb 2015

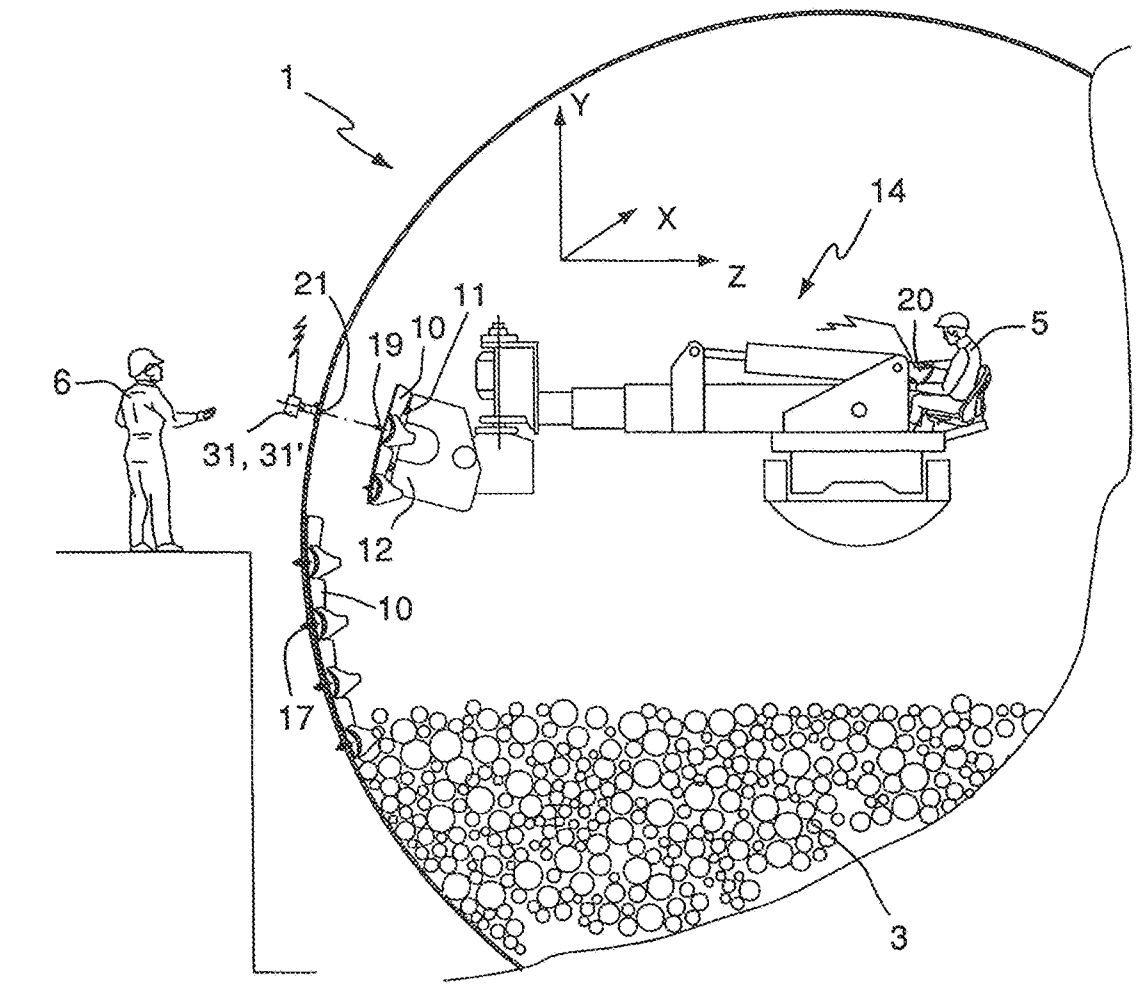
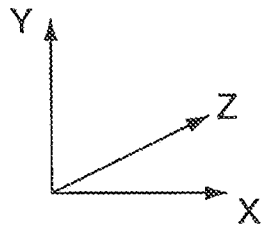


FIG.1



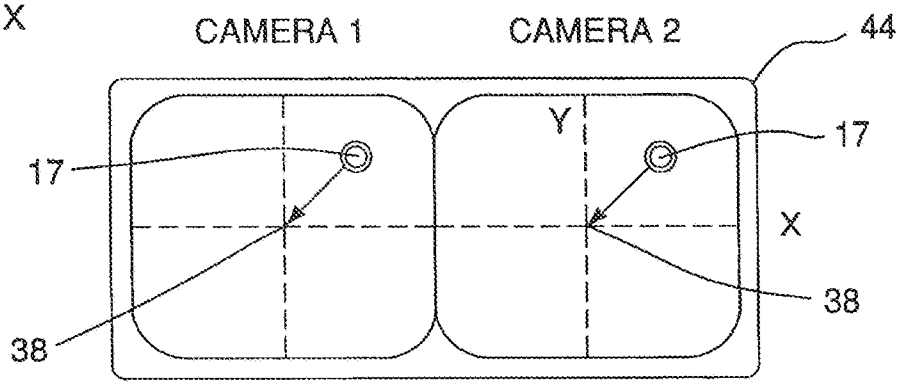


FIG.6a FIG.6b

2015201044 27 Feb 2015

CONTROL AND POSITIONING SYSTEM FOR THE EXCHANGE OF WEAR LINING ELEMENTS ON A WALL SUBJECT TO WEAR

FIELD

The present disclosure relates to a control and positioning system for indication of a relative position between an exchangeable wear lining element and a predetermined mounting position on a surface formed on an inner surface of a wall subject to wear, for example in equipment that handles crushed ore or stone material.

The disclosure also relates particularly but not exclusively to a system that is used in equipment that handles crushed ore or stone material. The disclosure also relates particularly but not exclusively to a system that makes it possible to carry out such an exchange of wear lining through remote control and two-way communication over the internet.

DEFINITION

In the specification the term “comprising” shall be understood to have a broad meaning similar to the term “including” and will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. This definition also applies to variations on the term “comprising” such as “comprise” and “comprises”.

BACKGROUND

A wall that is subject to wear, such as the jacket of a grinding drum that is used during the crushing and enrichment of ore, is covered on the inner surface that is subject to wear with a wear lining of, for example, elastomeric material. This wear lining is normally anchored by screw attachment against a surface of the cylindrical jacket of sheet metal that forms the rotating drum of the grinder. The wear lining of the grinding drum is formed from a number of wear lining elements laid next to each other in sections, which elements are attached to the inner surface of the drum with the aid of attachment means in the form of, for example, bolts that pass through mounting holes arranged in the jacket sheet metal of the drum. Since the wear lining elements are placed in position against the side of the jacket wall that is subject to wear, but are mounted through attachment holes from the opposite side of the jacket surface, what is known as the "tensioning surface", significant problems arise during the adaptation of each individual wear lining element such that the attachment means of the wear lining

2015201044 27 Feb 2015

element, which in its simplest form may include trivial attachment holes in the wear lining element, are located centrally relative to each attachment hole in the jacket before the wear lining element is lowered into place. The wear lining elements are very heavy and require lifting aids such as the arms of cranes, manipulators, or similar, for the handling of the wear lining elements inside the drum. Grinding drums of this type are normally in operation 24 hours a day, and this means that the lining is subject to very heavy wear and must be exchanged relatively frequently. When replacing the lining, the lining elements are lifted into the drum from one end and placed against a support surface on the inner surface of the jacket. Even if the crane operator is skilled, the adaptation itself of the wear lining elements onto the jacket surface is time-consuming and dangerous work, particularly if the wear lining elements are of the type that uses what are known as "drop-through bolts" and nuts. Exchanging drum lining is, furthermore, expensive due to the fact that it normally involves long interruptions of the production.

Various types of lifting and handling equipment, such as lifting cranes, intended to facilitate the exchange of drum linings are known. Such handling equipment normally comprises a lifting arrangement, such as an arm or a lifting crane, that can be manoeuvred inside the grinding drum and that is provided at its free end with a grip arrangement with which a wear lining element can be gripped and supported in a retaining manner. With the aid of the lifting crane, the grip arrangement and thus the lining element can be displaced essentially freely in space or with at least two or three degrees of translational freedom in space, i.e. in the x-, y- and z-directions, and with the aid of a number of rotational degrees of freedom also its attitude can normally be controlled, for example the roll, pitch and yaw angles of the grip arrangement. This can be described as a first angle α, which is defined in the xy-plane, a second angle β, which is defined in the yz-plane, and a third angle γ, which is defined in the xz-plane. The number of degrees of freedom of the manoeuvrable arm may vary, depending on the specific design of the lifting arrangement. The manoeuvring of the lifting arrangement normally takes place with an operator who accompanies the lifting arrangement or who is present in its immediate vicinity and who controls it with a control unit.

As has been mentioned above, one of the major problems when exchanging drum linings is the difficulty of positioning and adapting each individual wear lining element such that its attachment means are located in the centre of the attachment holes that are arranged in the drum wall before the wear lining element can be lowered

2015201044 27 Feb 2015

into place and the attachment elements applied such that the attachment of the wear lining can be made possible with the aid of supplementary attachment means. The said supplementary attachment means is normally constituted by a system of bolted joints whereby the wear lining element is placed under tension against the inner surface of the grinding drum through screws being introduced through existing attachment holes in the elements and onwards out of the mounting holes in the grinding drum, whereby the screws are held in place by means of nuts on the outer surface (the tensioning surface) of the grinding drum. In SE 531 347 C2, however, a new mounting technology is described in which the wear lining elements are equipped with threaded holes with associated guide pegs. Thus, nuts are not required. Attachment is achieved by means of bolts (such as screws) that are introduced through mounting holes from the outer surface of the grinding drum (the tensioning surface). During mounting of wear lining elements, it is generally the case that the crane operator, by radio or similar, is in wireless connection with personnel who are in the close vicinity of the intended mounting location of the wear lining element or a support surface on the wall. The crane operator receives commands and information about how the wear lining element is to be oriented in order for the mounting holes of the wear lining element to be located in line with and central to the mounting holes of the wall. In order to provide the information required to make it possible for the crane operator to bring together the supplementary attachment means in the mounting holes of the wear lining element, the personnel must be present dangerously close to the mounting location and, in certain cases, under the wear lining element that is suspended from the crane arm. It should be realised that this operation is highly risky, not least because the wear lining sections that are being exchanged are normally very heavy.

Some prior liner handlers are based on traditional hydraulics with valve packs that are controlled by sticks. However these systems do not provide high end control systems with fine tolerance motor control and movement of the liner. However in view of the workplace safety considerations and the need to operate plants efficiently it would be desirable to have a handler liner with improved control.

The reference to prior art in the background above and also in the detailed description below is not and should not be taken as an acknowledgment or any form of suggestion that the referenced prior art forms part of the common general knowledge in Australia or in any other country.

SUMMARY OF DISCLOSURE

2015201044 27 Feb 2015

A first purpose of the present disclosure is to achieve a control and positioning system that may solve the problems described above and that may make it possible to carry out, in a manner that is safer for the personnel and more efficient, the exchange of worn drum linings on walls that are subject to wear, in particular for rotating drum mills. What is particularly aspired to is to achieve a control and positioning system that ensures that personnel do not have to work under a crane arm from which lining sections are suspended, as has been described above.

In a first broad aspect this may be achieved by providing a control and positioning system for an indication of a mounting condition of an exchangeable wear lining element on a surface of a wall that is subject to wear, whereby the wall is provided with a set of mounting holes and the wear lining element includes an attachment means on its lower surface wherein the wear lining element is tightened against the surface by a supplementary attachment means that is passed through the mounting holes, wherein the system comprises:

a first reference system (Rv) formed by the mounting holes of the wall,

a second reference system (Rs) formed by the attachment means, and

a sensor that is arranged on the wall, having a field of view that contains the lower surface of the wear lining element viewed through the mounting holes, wherein the sensor transmits an electrical signal that represents an image of the relative position between the two reference systems (Rv, Rs), for guiding a crane operator to mount the wear lining element on the wall.

The sensor may be a two-dimensional sensor that is arranged to be stationary at the outer surface of the wall, on an opposite side of the wall of the mounting surface to that which is exposed to wear,

The surface of the wall may be constituted by an inner surface of a rotating drum of an ore grinder, and the wear lining element may be supported at the free end of a manoeuvrable arm that is a component of a lifting arrangement that is controlled during the handling of the wear lining element during a mounting operation by a crane operator.

In a second aspect this purpose may also be achieved through a control and positioning system for an indication of a mounting condition of an exchangeable wear lining element at a surface at a wall that is subject to wear, which may be constituted by, for example, the inner surface of a rotating drum of an ore grinder, and where the wear lining element is supported at the free end of a manoeuvrable arm that is a component of a lifting arrangement that is controlled during the handling of the wear

20152010044 27 Feb 2015

lining element during a mounting operation by a crane operator, whereby the wall is provided with a set of mounting holes and the wear lining element is equipped on its lower surface with attachment means, whereby the wear lining element is intended to be tightened against the surface of the wall by means of supplementary attachment means that are introduced through the mounting holes, wherein the system comprises:

a first reference system (Rv) formed by the mounting holes of the wall,

a second reference system (Rs) formed by the attachment means located on the lower surface of the wear lining element,

a two-dimensional sensor that is arranged to be stationary at the outer surface of the wall, i.e. on the opposite side of the wall of the mounting surface to that which is exposed to wear, in such a manner that the field of view of the sensor contains the lower surface of the wear lining element viewed through the mounting holes, whereby the sensor is arranged to transmit an electrical signal that represents an image of the relative position between the two reference systems (Rv, Rs), and with the guidance of which image the mounting position of the wear lining element at the wall can be determined by the crane operator.

In a third aspect of the disclosure the purpose may further be achieved by providing a control and positioning system for an indication of a mounting condition of an exchangeable wear lining element at a surface of a wall that is subject to wear, where the wall is provided with a set of mounting holes and the wear lining element is equipped on its lower surface with attachment means, whereby the wear lining element is intended to be tightened against the surface of the wall by means of supplementary attachment means that are introduced through the mounting holes, wherein the system comprises:

a first reference system (Rv) formed by the mounting holes of the wall,

a second reference system (Rs) formed by the attachment means located on the lower surface of the wear lining element,

a two-dimensional sensor that is arranged to be stationary at the outer surface of the wall, on an opposite side of the wall of the mounting surface to that which is exposed to wear, in such a manner that the field of view of the sensor contains the lower surface of the wear lining element viewed through the mounting holes, whereby the sensor is arranged to transmit an electrical signal that represents an image of the relative position between the two reference systems (Rv, Rs), and with the guidance of which image the mounting position of the wear lining element at the wall can be determined by the crane operator.

2015201044 27 Feb 2015

The control and positioning system may include any one or more of the features of the system described above in the first aspect.

A second purpose of the present disclosure is to achieve a system that makes it possible to carry out renovation and exchange of wear linings without it being necessary for the crane operator to be present at the site of the lining operation.

Due to a two-dimensional sensor being arranged at the outer surface of the wall, i.e. on the opposite side of the wall seen from the wear of the mounting surface, in such a manner that the field of view of the sensor contains the lower side of the wear lining element viewed through the mounting holes, and due to the sensor being arranged to emit an electrical signal that represents an image of the relative position between a first reference system Rv that is constituted by the mounting holes of the wall and a second reference system that is constituted by the attachment means located on the lower surface of the wear lining element, which may, of course, include also trivial mounting holes, it is possible for the mounting position of the wear lining element to be determined in a simple and efficient manner, and thus for the wear lining element to be guided to its mounting location on the wall.

It is appropriate that the two-dimensional sensor comprise two imaging cameras that are arranged stationary relative to the first reference system Rv such that the lines of sight from the outer surface of the drum jacket of these sensors pass through the mounting holes of the grinding drum. An image processing unit is a component of the system, which unit converts the signal to a two-dimensional or three-dimensional representation and a display unit with which the positional information can be presented to the crane operator in real time such that the crane operator can guide and manoeuvre the lifting arrangement and in this way bring the wear lining element into its mounting position against the wall. The crane operator can in this way see the "field of view of the camera" and in this way through reception of information in real time can view the lower surface of the wear lining element on the monitor through the use of the direct information from the display unit in order to position accurately the wear lining element in its place against the support surface of the inner surface of the grinding drum such that the attachment means that are present on the lower surface of the wear lining element are located centrally in a relevant mounting hole in the wall.

In an alternative design, it is conceivable that the actual guidance or positioning procedure can take place automatically, based on the information that is received from the image processing unit of the system, whereby critical operations during the exchange of wear linings can be automated. When the crane operator is

2015201044 27 Feb 2015

satisfied with the position, the positioning function is activated by pressing a button at the control unit. The camera then captures an image of a cross on a panel and calculates the position of its centre and its distance with the aid of a laser beam, whereby a microprocessor calculates, in a manner that is known, the data required and guides the lifting arrangement, and thus also the wear lining element, into place. In another design, it is conceivable that information concerning the positions of the attachment means relative to the mounting holes, as a supplement to the purely visual information that a crane operator receives from images in a monitor, may be tactile, or it may be audiovisual in which an image that is displayed on a monitor corresponds to the tactile or audiovisual information.

A further aspect of the present disclosure therefore resides in a method for guiding a wear lining element onto a predetermined mounting position on a surface of a wall that is subject to wear, whereby the wall is provided with a set of mounting holes, the wear lining element includes an attachment means on its lower surface, and the predetermined mounting position is a position in which the supplementary attachment means is able to be passed through the mounting holes in the wall; the method comprising;

providing a first reference system (Rv) formed by the mounting holes of the wall;

providing a second reference system (Rs) formed by the attachment means;

providing a sensor that is arranged on the wall that has a field of view that contains the lower surface of the wear lining element viewed through the mounting holes that can generate an electrical signal that represents the relative position between the reference systems (Rv, Rs);

providing a manoeuvrable arm that is a controllable component of a lifting arrangement;

mounting the wear liner element to the manoeuvrable arm;

and using the generated signal to control the manoeuvrable arm so as to guide the wear lining element onto the predetermined mounting position.

The electrical signal may represent an image of the relevant position between the reference systems (Rv, Rs).

The lifting arrangement may be part of a crane and the image may be transmitted for viewing by a crane operator in real time for guiding the wear lining element onto the predetermined mounting position.

2015201044 27 Feb 2015

The crane operator may be located within the crane or remote from the crane. Remote control of lifting and handling equipment is known in the art by methods including those as discussed below.

The electrical signal may also be used to automatically control the manoeuvrable arm so as to guide the wear lining element onto the predetermined mounting position.

Also disclosed herein is the use of an image recorder for the determination of the relative position between an exchangeable wear lining element and a determined mounting position for the element on a surface formed on the inner surface of a wall subject to wear with mounting holes for the wear lining element, whereby the camera is arranged such that it "sees" the lower surface of the wear lining element through a mounting hole in the wall.

The term “camera” includes any device capable of capturing an image within the electromagnetic spectrum and includes visible light capture, ultraviolet light capture and reflected laser light capture.

One of the major advantages of the present control and positioning system is that alignment of the wear lining element with the mounting holes of the support surface is considerably facilitated and, in particular, through it not being necessary for personnel to be present in the immediate vicinity of the wear lining element during the actual work of alignment and positioning. All positioning can take place with high accuracy at a safe distance from the site of mounting. As an alternative, it would be possible for a crane operator to work using remote control and an external communication unit in a system in which data is transferred in two directions over, for example, the internet or a WLAN, whereby it is appropriate that one single experienced crane operator can control one or several lifting arrangements or manipulators for the handling of wear lining elements from a significantly remote location. The cost savings and the increase in efficiency that can be obtained in the latter case are obvious, since it is not necessary for an experienced crane operator to travel to the location, such as a mine, where, for example, an ore grinder is located, but can instead manoeuvre the lifting arrangement in a wireless manner from a distant terminal.

DETAILED DESCRIPTION

An embodiment of the disclosure will be described below in more detail with reference to attached drawings, of which:

Figure 1 shows a cross-sectional view through a part of a typical grinder installation with a lifting arrangement arranged in this installation, which lifting

2015201044 27 Feb 2015

arrangement, in order to position a wear lining element, wherein an operator uses a control and positioning system according to the present disclosure;

Figure 2 shows an exploded view in perspective of a part of a grinding drum with the control and positioning system according to the disclosure during the positioning of a wear lining element against a support surface of the inner surface of the drum, that is subject to wear, and the mounting of the wear lining element with attachment bolts that, passing through the mounting holes in the jacket of the grinding drum, are intended to be mounted from the outer surface of the drum, i.e. the surface that is known as the "tensioning surface";

Figure 3 shows a perspective view of a protective housing for an image recording camera and a source of illumination that is a component of the control and positioning system according to the disclosure;

Figure 4 shows a perspective view of a digital image recording camera with its associated source of illumination in the form of LEDs, distributed around the camera lens and being components of a control and positioning system according to the disclosure;

Figure 5 shows a block diagram of a control and positioning system according to the present disclosure intended to be used at a lifting arrangement for the handling of wear lining elements in order to facilitate exchange of wear lining in a rotatable grinding drum;

Figures 6a and 6b show computer images such as a crane operator sees them and divided into sessions using a DualScreen system in which each image has been created by a first and second image recording camera, respectively, that are components of a control and positioning system according to the disclosure;

Figures 7a-7c show schematically in an example the mutually different angular positions that may arise between two mounting holes that are included in the fixed first reference system Rv that is defined by the jacket wall (the X/Y plane) of the grinding drum and two attachment means that are components of the moveable second reference system Rs that is defined by a wear lining element that is being handled by a lifting arrangement, whereby:

a) the two attachment means of the wear lining element are placed with their longitudinal axes perpendicular to the X/Y plane,

b) the two attachment means of the wear lining element are placed with their longitudinal axes at an angle of 25° to the X/Y plane, and

2015201044 27 Feb 2015

c) the two attachment means of the wear lining element are placed with their longitudinal axes at an angle of -25° to the X/Y plane;

Figures 8a-8c show schematically an example of how a graphical two-dimensional image may appear, i.e. sessions with a DualScreen structure that are presented to a crane operator via a monitor at different conditions of the angular position between two of the mounting holes of the jacket wall and two of the opposing attachment means of the wear lining element corresponding to Figures 7a-7c, whereby:

a) the attachment means lie centrally in the mounting holes, i.e. the attachment means are perpendicular to the X/Y plane

b) the attachment means are located obliquely at an angle to the mounting holes, i.e. the attachment means are at an angle of 25° to the X/Y plane

c) the attachment means are located obliquely at an angle to the mounting holes, i.e. the attachment means are at an angle of -25° to the X/Y plane;

Figure 9 shows a system for the remote control operation of a crane arrangement that when carrying out the exchange of wear lining in a grinder uses geometrical information in order to assess the angular positions between the different reference systems Rv, Rs in a control and positioning system according to the present disclosure.

Figure 1 shows a cross-section through a part of a typical grinding drum 1 with a surrounding wall in the form of a sheet metal jacket 2 that is subject to wear, which grinding drum is used during the crushing and milling of ore 3 in an ore grinder. A first operator 5, a crane operator, is located inside the drum while a second operator 6 is located outside of the drum. The two operators 5, 6 can communicate in a wireless manner with each other through, for example, a mobile telephone or radio link. An internal drum lining at a drum mill 1 of the said type is formed from a number of wear lining elements 10, known as "jacket plates", located next to each other. Each wear lining element 10 has lifting lugs 11 designed for interaction with a hooked gripper 12 that is located at the free end of a lifting arrangement 14 that has been introduced into the grinding drum 1. A wear lining element 10 demonstrates an upper surface 15 that faces in towards the centre of the grinding drum 1 manufactured from a material that resists wear such as, for example, wear rubber, and a lower surface 16 of metal attached by vulcanisation to the said wear rubber.

Since ore grinders of the type under consideration normally operate round-the-clock, the wear lining elements 10 must be exchanged at regular intervals. For this purpose, the wear lining elements 10 are equipped with attachment means general

2015201044 27 Feb 2015

denoted by 17, which in the embodiment described here comprise threaded holes 19 with associated guide pegs that can be released. The reference number 17' is used generally to denote supplementary attachment means intended for the mounting, which means are constituted by what are known as "bolted joints" in the form of screws 18 provided with a head 20 and intended to be introduced from the outer surface of the drum jacket through mounting holes 21 in the sheet metal jacket 2 of the grinding drum 1, to be screwed in place in threaded holes 19 in the wear lining element. Thus, this attachment system is essentially of the type that is known from SE 531 347 C2.

In this part it should be understood that the expression "attachment means 17" is used to denote any known type of attachment means with which the wear lining element 10 may be equipped, i.e. not only threaded holes with the associated guide pegs of the type that is described in this embodiment and in the document mentioned above, but also more simple systems of screw-nut type, known as "drop-through bolts", whereby the wear lining elements are provided with simple mounting holes.

The wear lining elements 10 are positioned centrally with respect to the mounting holes 21 in the sheet metal jacket 2, after which they are tightened against a surface on the inner surface of the jacket by being screwed by means of the said screws 18 from the outer surface of the sheet metal jacket 2, i.e. from what is known as the "tensioning surface". This type of wear lining element 10 is very heavy and difficult to handle and, even if the crane operator, i.e. the first operator 5 in the drawing, is skilled, there are severe difficulties in positioning and adapting each individual wear lining element 10 such that the attachment means 17 on the lower surface of the wear lining element 10 are located centrally with respect to each attachment hole 21 before the wear lining element can be lowered into place and fixed from the outer surface of the drum by means of the supplementary attachment means 17' by the second operator 6 who works outside of the grinding drum 1.

A lifting arrangement 14 with a crane design is shown in Figure 1 working inside the grinding drum 1. The gripper 12 that is arranged at the tip of the lifting arrangement 14 is in known manner equipped with pegs or hooks (not shown in the drawings) that can be inserted into the lifting lugs 11 of the wear lining element 10. When the said hooks have been introduced into the lifting lugs 12, a wear lining element 10 can be carried in a retaining manner by the lifting arrangement 14 and can in this manner be freely handled and positioned inside the grinder. The motion of the lifting arrangement 14 is controlled and monitored by means of control and actuator means 14a that are normally hydraulically operated, such as hydraulic cylinders, but

2015201044 27 Feb 2015

may be constituted alternatively by electrical servomotors. The control of the control and actuator means of the lifting arrangement 14 takes place through a control unit 14b such as a control valve unit with fluid connectors and through the influence of a control unit 20 with control and guide sticks that the first operator 5 who works inside the grinding drum, travelling with the lifting arrangement as a driver, has in front of him or her at the driving location. The first operator 5, who works inside the grinding drum 1, thus travels with the lifting arrangement 14 and thus controls its various motions by means of the control unit 20. The control unit 20 is equipped with the required buttons and knobs that through their influence and setting cause the lifting arrangement 14 to carry out the desired motions. With the aid of the lifting arrangement 14, the lining element can be displaced essentially freely in space or with at least two or three degrees of translational freedom in space, i.e. in the x-, y- and z-directions, and with the aid of a number of rotational degrees of freedom also its attitude can normally be controlled, for example the roll, pitch and yaw angles of the grip arrangement. This can be described as a first angle α, which is defined in the xy-plane, a second angle β, which is defined in the yz-plane, and a third angle γ, which is defined in the xz-plane.

In order for it to be possible to exchange worn out drum linings in rotating drum mills 1 in a more efficient and safer manner, a control and positioning system 30 is, according to the present disclosure, arranged to work together with the lifting arrangement 14. The control and positioning system 30 facilitates in particular the control and positioning of the crane arrangement 14 in real time by the first operator 5 who is located inside the grinding drum 1 in such a manner that the wear lining element 10 is located in exactly the right place against the support surface in the inner surface of the sheet metal jacket 2. The expression "in place" is used below to denote the following: that the attachment means 17 of the wear lining element 10, which attachment means are equipped with an internal thread, are located essentially centrally relative to the relevant mounting hole 21 in the jacket sheet metal 2 such that, for attachment under tension of the wear lining element, the supplementary attachment means 17' in the form of the screws 18 can be introduced by being passed through the mounting hole 21 and screwed into the attachment means 17, in the form of threaded holes 19, of the wear lining element 10. The term "real time" is used to denote that the first operator 5 who is operating the lifting arrangement, receives essentially without any delay in time, i.e. instantaneously, information about the position of the wear lining element 10 relative to the intended mounting location on the support surface of the inner surface of the drum jacket.

2015201044 27 Feb 2015

Figure 2 shows a control and positioning system 30 according to the present disclosure in more detail, whereby a first reference system Rv is defined by the mounting holes 21 of the drum jacket 2, and a second reference system Rs is formed by the attachment means 17 located on the lower surface of the wear lining element 10 in the form of holes 19 provided with internal threads. The control and positioning system 30 comprises further sighting means that, based on the two reference systems Rv, Rs, makes it easier for the crane operator 5 who is manoeuvring the lifting arrangement 14 to guide towards a determined mounting location on the inner surface of the sheet metal jacket. The sighting means of the control and positioning system comprises a two-dimensional sensor in the form of first and second image recording cameras 31, 31'. Each such image recording camera 31, 31' is of the type in which images are exposed on a digital image sensor and transferred as electrical signals representing a stream of still images or of image sequences of the relative position between the first and second reference systems Rv, Rs. A source of illumination is arranged at each image recording camera 31, 31' in the form of a source of light 32 with LEDs that are evenly distributed around a circle around the lens 33 of the image recording camera 31, 31' (Figure 4).

Figure 3 shows in more detail a camera housing 34 that can be opened, in which each of the said image recording cameras 31, 31' and its associated source of light 32 can be inserted and fixed. Attachment means 35 are present at the front end of the camera housing 34 in the form of a magnetic attachment with which the camera housing can be mounted in a manner that allows it to be removed on the outer surface of the jacket sheet metal 2 of the grinding drum 1 such that the two image recording cameras 31, 31' are fixed stationary relative to the first reference system Rv in the manner shown in Figure 2. Between the camera housing 34 and the attachment means 35 that is located at the front end there extends an intermediate tubular part 36a, and a ring-shaped guide 36b protrudes a short distance forwards from the attachment means 35. The lens 33 of the image recording camera 31, 31' is intended to extend a short distance into the rear end of the tubular part 36a, whereby the said part forms a receiving compartment for the lens. The tubular guide 36b that protrudes forwards from the attachment means 35 has been given an external diameter that has been selected such that it can be adapted as a probe into a mounting hole 21 in the jacket sheet metal 2. The tubular guide 36 is attached at the camera housing 34 by means of a bayonet fitting or similar in a manner that allows it to be removed, whereby the camera housing can be simply be provided with tubular guides 36 with different external

2015201044 27 Feb 2015

diameters in order for it to be possible to adapt these to drum jackets 2 with mounting holes of different internal diameters.

At the forward end of the tubular guide 36b of the camera housing 34 there is an opening 37 that, when the tubular guide has been inserted a certain distance into a mounting hole 21 in the jacket 2, not only allows images to be received and projected onto the digital image sensors of the image recording cameras 31, 31' that are inside the camera housing, but also allows light in the form of beams from the source of light 32 to stream out from the camera housing in order to illuminate the target, which is constituted by the lower surface of the wear lining element 10. While the two image recording cameras 31, 31' are fixed in position relative to the first reference system Rv (through the mounting holes 21) with a field of view that is constituted by the attachment means 17 located at the lower surface of the wear lining elements 10, the second reference system Rs of the system is obtained by suitable image processing of an electrical signal that represents an image of the said target, such as, for example, a two-dimensional image. This two-dimensional image makes it possible for the crane operator to interpret in real time the relative position between the two reference systems Rv, Rs, i.e. the relative position between the mounting holes 21 of the jacket sheet metal 2 and the attachment means 17 that are located at the lower surface of the wear lining element 10. Through the use of image rasterisation and different types of geometrical object forms that arise between the two reference systems Rv, Rs, i.e. comparisons of target values with actual values for projected surfaces, it is possible for a skilled crane operator to make conclusions about the relative positions of the two reference planes (their characteristics), and how the lifting arrangement is to be manoeuvred in order for the attachment means 17 of the wear lining element 10 and thus also the reference system Rs to be located centrally relative to the first reference system Rv. According to the disclosure, the relative position between the two reference systems Rv, Rs is determined in the presence of a flow of light that is produced by a source of light 32. It should be understood that other suitable sources of illumination such as laser light or IR light can be used in order to make the relative position between the two reference systems Rv, Rs visible in an image recording camera.

Figure 4 shows an image recording camera 31, 31' in more detail, by which it is made clear that the lens 33 comprises cross-hairs 38 that form an origin in the centre of the mounting hole 21. Due to the source of light 32, the cross-hairs 38 form an illuminated reference point, the purpose of which will be described in more detail below. Each image recording camera 31, 31' and each source of light 32 is so arranged in the

2015201044 27 Feb 2015

camera housing 34 that with the attachment means 35 mounted over one of the mounting holes 21 of the grinding drum, the image recording camera 31, 31' has its line of sight into the centre of the grinding drum, or - to put it another way - it "sees" in towards this centre. The source of light 32 projects in a similar manner a beam 40 through the mounting hole 21 that intersects the lower surface 16 of a wear lining element 10 that is being handled by means of the lifting arrangement 14 inside the grinding drum 1.

Figure 5 makes it clear in more detail that each image recording camera 31, 31' is connected through an image processing unit 42 to a monitor 44 that receives and projects image signals from the two image recording cameras 31, 31'. The communication between the said units can be achieved in any suitable manner, for example through networks and wireless communication links to one or several access points in the form of what are known as radio base stations, arranged within a mine area with a number of operating grinders. The image information can be transferred through the wireless connections via the internet or a WLAN over very long distances, even between different parts of the world, whereby it would be possible for one single experienced crane operator to control remotely from an operating location using external communication one or a number of lifting arrangements 14 or manipulators during the exchange of wear linings in mine facilities located far away. In the embodiment that is described here, the first operator 5, who works inside the grinding drum 1, travels with the lifting arrangement 14 and controls it's various motions by means of the control unit 20. It is an advantage if the monitor 44 can be adapted to display for the operator 5 stereotactic images from each one of the two image recording cameras 31, 31' at the same time using what is known as a "split screen". Another way of saying this is that sessions are formed on a Dual Screen with images 44a, 44b from the first and the second image recording cameras 31, 31', respectively. Since it is known that two reference points or reference data are required in order to guide an object to an exact position on a plane, i.e. on the plane that the support surface for a wear lining element 10 that the inner surface of the sheet metal jacket 2 of the grinding drum 1 forms, it should be realised that it is an advantage if both camera images 44a, 44b can be shown stereo-tactically on the monitor 44, i.e. in the manner that is illustrated in Figures 6a and 6b.

The reference points are denoted in Figures 6a and 6b each with cross-hairs 38, while each target is denoted with attachment means 17. As a consequence of the stereotactic images that the monitor is conveying at any moment through the two

2015201044 27 Feb 2015

camera images 44a, 44b (Figures 6a, 6b) that are obtained on the monitor 44 that is integrated into the control unit 20, the first operator 5 is able to rapidly localise the exact location at the sheet metal jacket 2 for the wear lining element 10 and the position in which the two reference systems Rv and Rs lie centrally relative to each other with their X/Y planes parallel. Another way of saying this is that the operator can localise the condition in which two of the attachment means 17 of the wear lining element 10 are located centrally relative to the relevant mounting holes 21 in the jacket 2 and in which the attachment means 17 of the wear lining element 10 are perpendicular to the X/Y plane. Thus the cross-hairs 44 form in the monitor 44 the reference system required by the first operator 5 who operates the crane. Though operating the levers and knobs of the control unit 20, the wear lining element 10, which is supported by the lifting arrangement 14, is positioned in place such that two of its attachment means 17 are located centrally relative to the relevant mounting hole 21 in the jacket sheet metal 2, after which the wear lining element is lowered into place. The second operator 6 tightens the wear lining element 10 against the inner surface of the grinding drum through screws 18 being introduced through the mounting holes 21 and being screwed into the attachment means 17 of the wear lining element from the outer surface (the tensioning surface) of the grinding drum 1.

Figure 7 shows schematically different angular positions that may arise between two mounting holes 21 that are included in the fixed first reference system Rv that is defined by the jacket wall 2 (the X/Y plane) of the grinding drum, and two attachment means 17 (schematic depicted here as cylinders) that are components of the moveable second reference system Rs that is defined by a wear lining element 10 that is being handled by a lifting arrangement 14. The two attachment means 17 of the wear lining element 10 in Figure 7a are placed with the longitudinal axis perpendicular to the X/Y plane that is defined by the mounting openings 21 of the jacket plate 2. The two attachment means 17 of the wear lining element 10 in Figure 7b are placed with the longitudinal axis at an angle of 25° to the X/Y plane that is defined by the mounting openings 21 of the jacket plate 2. The two attachment means 17 of the wear lining element 10 in Figure 7c are placed with the longitudinal axis at an angle of -25° to the X/Y plane.

Figure 8 shows schematically the different angular positions that can arise between the two reference systems Rv, Rs that are also illustrated in Figures 7a-7c, but in this case shown based on the field of view of the two-dimensional sensor 31, 31'. Thus, in Figures 8a-8c there are illustrated the ways in which the two image recording

2015201044 27 Feb 2015

cameras 31, 31' view the attachment means 17 of the wear lining element 10 through the mounting holes 21 and the geometrical images that are presented in the form of a two-dimensional image 44a, 44b to the crane operator on the display unit 44 or monitor at the operating place of the lifting arrangement 14 (see also Figure 5). The images from each of the cameras 31, 31' are denoted by a1-c1 and a2-c2, respectively. In a similar way to that described above, Figure 8a shows a condition in which the two attachment means 17 of the wear lining element 10 are located with the longitudinal axis perpendicular to the X/Y plane that is defined by the mounting openings 21 of the jacket plate 2. The two attachment means 17 of the wear lining element 10 in Figure 8b are placed with the longitudinal axis at an angle of 25° to the X/Y plane that is defined by the mounting openings 21 of the jacket plate 2. The two attachment means 17 of the wear lining element 10 in Figure 8c are placed with the longitudinal axis at an angle of -25° to the X/Y plane.

As has been described above, the wear lining element 10 can be displaced with the aid of the lifting arrangement 14 essentially freely in space or in at least two or three degrees of translational freedom in space, i.e. in the x-, y- and z-directions, and with the aid of a number of rotational degrees of freedom also its attitude can normally be controlled, for example the roll, pitch and yaw angles. Under guidance of an image sequence from the display unit 44, i.e. the monitor that the crane operator 5 has at the operating place, the operator can guide and manoeuvre the wear lining element to its location, after which it is lowered and fixed in place from the outer surface of the drum, i.e. from the mounting side.

Figure 9 shows a system that allows remote control of the control and positioning system that has been described above and that makes it possible for an experienced and skilled crane operator 5 to work using remote control in a system in which data is transferred over, for example, the internet or a WLAN. In this way it would be possible for the renovation and lining of grinders to be carried out without qualified personnel needing to be at the site, whereby an experienced crane operator would be able with the aid of the present control and positioning system to remotely control externally one or several lifting arrangements or manipulators inside different grinders at different places in the world. A system that allows this comprises a lifting arrangement 14 that is equipped with a control unit 14b, i.e. a control valve unit that allows remote control through a control unit 20b comprising guidance and control levers. Hydraulic systems that allow remote control normally include transmitters and receivers where control signals in the form of infrared radiation are transmitted as

2015201044 27 Feb 2015

electrical control commands to a control in the control unit 14b of the machine and have been well known for a long time, and will therefore not be described in more detail. The present system comprises furthermore an image processing unit 42 intended to receive images from the first and second cameras 31, 31', a wireless communication module 108, a wireless IP-sharing arrangement 60 (where "IP" is an abbreviation for "internet protocol"), and a distant workplace for an operator comprising a computer terminal 120 that is connected to the internet 100 and to which has been assigned a control unit 20b comprising a control stick (joystick) for the manoeuvring of the crane arrangement 14. Image signals taken by the two cameras 31, 31' are sent to the image processing unit 42 and after processing in this unit are sent as an image signal through the wireless communication module 108 and the wireless IP-sharing unit 60. The wireless communication module receives also control signals from the computer terminal 120 and the control system 20b for the control unit 14b and thus the commands for the manoeuvring and guidance of the lifting arrangement 14. Two-way data communication thus takes place over the internet 100. The wireless communication module 108 may be a wireless USB-adapter or a wireless LAN card that is compatible for use with the wireless IP-sharing arrangement 60. Control signals for the control unit 14s are given by keyboard commands 120 at the computer terminal in combination with joystick commands through the control stick 20b, whereby these commands are received by the IP-sharing module 60 to be passed on to the system control 14a through the communication module 108. The wireless IP-sharing arrangement 60 is thus connected to the internet line 120 not only to feed out image data from the cameras 31, 31', but also to pass control signals in to the control and actuator means 14a of the lifting arrangement 14. A crane operator 5 who sits in front of the computer terminal 120, 20, while being geographically remote from the site, for example the grinder 1, thus can control all motion of the lifting arrangement 14 by means of the control stick 20b with the aid of the geometrical images between these two that are displayed on the monitor 44 from each one of the two image recording cameras 31, 31' and the two reference systems Rv and Rs.

In operation of the system described above with reference to the drawings, in one form the operator would manually manoeuvre the liner into its broad position with the crane. Then when the mill liner comes into the field of view of the camera, the control and positioning system or liner handler would start operating. In particular the operator has a docking button on the operator control. Data from the cameras will then

2015201044 27 Feb 2015

be transferred to the liner handler control system to provide fine motor movements to put the mill liner in the correct position for mounting on the wall.

Further in another form the control and positioning system or liner handler would control the entire process from when the mill liner is attached to a grapple tool of the liner handler to when the mill liner is correctly positioned with the mounting holes aligned with the attachment means on the wall so that the attachment bolts can easily be installed and then fastened.

There are some variations in the way which the camera communicates with the rest of the control and positioning system. In some embodiments digital smart cameras are connected by cables, e.g. power cord and signal cable, to a Wi-Fi router which in turn communicate with the system. That is the cameras are hard-wired to the Wi-Fi router.

In yet other embodiments that have not been illustrated the sensor or sensors may be cameras that have wireless network connectivity. Such cameras may be of the types found in personal digital assistance (pdas) and smart phones. Further, some dedicated (that is cameras that do not form part of a pda or smart phone) digital and compact cameras also have wireless internet connectivity.

Smart phones which include a camera have been used to transfer the images to a controller. The smart phones include a camera, an LED light, internal battery power, computer power, an ability to use both a standard and customised software applications or apps. Further smart phones or pdas also offer an in-built ability to transmit signals over a wireless network, e.g. 3G or 4G or indeed any other wireless network that is accessible to the smart phone or pda. Yet further smart phones or pdas also offer the ability to transmit images wirelessly using a blue tooth system.

Further there are variations in the type of camera that can be used. For example in some embodiments a traditional video camera might be used. Instead in some other embodiments an imaging device or image recording device that operates outside of the wavelength frequency range for visible light in the electromagnetic spectrum. For example the imaging device may sense an image of infra-red radiation, ultra-violet, laser radiation or indeed other technologies working with different wavelengths.

In addition to the applications described above with reference to the illustrated embodiments, Applicant also envisages use of the system for studying relining metrics including workplace safety and process efficiency. For example the system could be used to monitor installations, e.g. time and motion studies, and learn how to improve

2015201044 27 Feb 2015

workflow practices and workplace safety during relining operations. As relining is a high cost maintenance operation there is a need for work place studies to improve practices with a view to improving safety and saving money.

Finally it will readily be appreciated by a person skilled in the art that Applicant contemplates that in at least one embodiment the camera system will be fully integrated into a liner handler apparatus that is produced. However it is not necessary that this is the case.

The invention is not limited to what has been described above and shown in the drawings: it can be changed and modified in several different ways within the scope of the innovative concept defined by the attached patent claims.

2015201044 17 Feb 2017

CLAIMS:

1. A control and positioning system for an indication of a mounting condition of an exchangeable wear lining element on a surface of a wall that is subject to wear, whereby the wall is provided with a set of mounting holes and the wear lining element includes an attachment means on its lower surface wherein the wear lining element is tightened against the surface by a supplementary attachment means that is passed through the mounting holes, wherein the system comprises:

a first reference system (Rv) formed by the mounting holes of the wall;

a second reference system (Rs) formed by the attachment means; and

a sensor that is arranged on the wall, having a field of view that contains the lower surface of the wear lining element viewed through the mounting holes, wherein the sensor transmits an electrical signal that represents an image of the relative position between the two reference systems (Rv, Rs), for guiding a crane operator to mount the wear lining element on the wall.

2. A control and positioning system according to claim 1, wherein the surface of the wall is constituted by an inner surface of a rotating drum of an ore grinder.

3. A control and positioning system according to claim 1 or claim 2, wherein the wear lining element is supported at the free end of a manoeuvrable arm that is a component of a lifting arrangement that is controlled during the handling of the wear lining element during a mounting operation by a crane operator.

4. A control and positioning system according to any one of claims 1 to 3, wherein the sensor is a two-dimensional sensor that is arranged to be stationary at the outer surface of the wall, on an opposite side of the wall of the mounting surface to that which is exposed to wear.

5. The control and positioning system according to claim 4, wherein the two-dimensional sensor comprises two image recording cameras that are secured to the first reference system (Rv) in such a manner that their fields of view contain the attachment means located at the lower surface of the wear lining element viewed through the mounting holes.

6. The control and positioning system according to claim 5, comprising an image processing unit that converts the electrical signal from the image recording cameras to a graphic two-dimensional image and a display unit with which the image can be presented in

2015201044 17 Feb 2017

real time for the crane operator so that he or she can guide and manoeuvre the lifting arrangement and in this way bring the wear lining element into its mounting position at the wall.

7. The control and positioning system according to any one of claims 4 to 6, wherein the two-dimensional sensor comprises a ring-shaped guide intended to be introduced as a probe into the mounting holes of the wall for geometric determination of the geometric position of the first reference system (Rv).

8. The control and positioning system according to claim 7, comprising a housing in which an image recording camera and a source of illumination are positioned, and which housing is equipped at a forward end with the ring-shaped guide and an attachment means that allows the housing to be mounted at the outer surface of the wall in association with a mounting hole, in a manner that allows it to be removed.

9. The control and positioning system according to claim 8, wherein the attachment means comprises a magnetic attachment.

10. The control and positioning system according to any one of claims 5 to 9, wherein each image recording camera comprises a lens at which the source of illumination is arranged as a set of LEDs, distributed around the circumference of the lens.

11. The control and positioning system according to any one of claims 1 to 10, comprising a source of illumination that is arranged to emit light from the outer surface of the wall through the mounting holes or openings of the wall in a direction towards the lower surface of the wear lining element.

12. The control and positioning system according to any one of claims 1 to 11, comprising a lifting arrangement of the type that demonstrates a control unit provided with a transmitter and receiver in order to allow remote control of the control and actuator means of the lifting arrangement and where control signals are sent as electrical control commands to a control in the control unit of the arrangement, an external communication unit that offers a two-way communication connection over the internet with a control unit and the image processing unit and with which a crane operator located at a distance can in real time guide and control the relative positions of the reference systems (Rv, Rs).

2015201044 17 Feb 2017

13. The control and positioning system according to claim 12, wherein the external communication unit comprises a computer terminal with an associated control stick.

14. The use of an image recorder for the determination of the relative position between an exchangeable wear lining element and a determined mounting position for the element on a surface formed on the inner surface of a wall of a rotating drum of an ore grinder that is subject to wear with mounting holes for the wear lining element, whereby the camera is arranged such that it "sees" the lower surface of the wear lining element through a mounting hole in the wall.

15. A method for guiding a wear lining element towards a predetermined mounting position on a surface of a wall that is subject to wear, whereby the wall is provided with a set of mounting holes, the wear lining element includes an attachment means on its lower surface, and the predetermined mounting position is a position in which the attachment means is able to be passed through the mounting holes in the wall; the method comprising:

providing a first reference system (Rv) formed by the mounting holes of the wall;

providing a second reference system (Rs) formed by the attachment means;

providing a sensor that is arranged on the wall that has a field of view that contains the lower surface of the wear lining element viewed through the mounting holes that can generate an electrical signal that represents an image of the relative position between the reference systems (Rv, Rs);

providing a manoeuvrable arm that is a controllable component of a lifting arrangement;

mounting the wear liner element to the manoeuvrable arm; and

providing an operator with the image such that the operator can be guided by the image to guide and manoeuvre the manoeuvrable arm so as to guide the wear lining element towards the predetermined mounting position.

16. The method of claim 15, wherein the image is a graphic two dimensional image that is displayed on a display unit for representing the image to the operator.

17. The method of claim 16, wherein the lifting arrangement is part of a crane and the image is displayed for viewing by the crane operator in real time for guiding the wear lining element towards the predetermined mounting position.

18. The method of claim 17, wherein the crane operator is remote from the crane.

2015201044 17 Feb 2017

19. The method of claim 17 or claim 18, wherein the lifting arrangement comprises a control unit provided with a transmitter and receiver in order to transmit the image to the remote crane operator and to receive control signals from the remote crane operator to allow remote control of the lifting arrangement.

20. The method of claim 18 or claim 19, wherein the electrical signal is also used to automatically control the manoeuvrable arm so as to guide the wear lining element onto the predetermined mounting position.

20152010044 27 Feb 2015

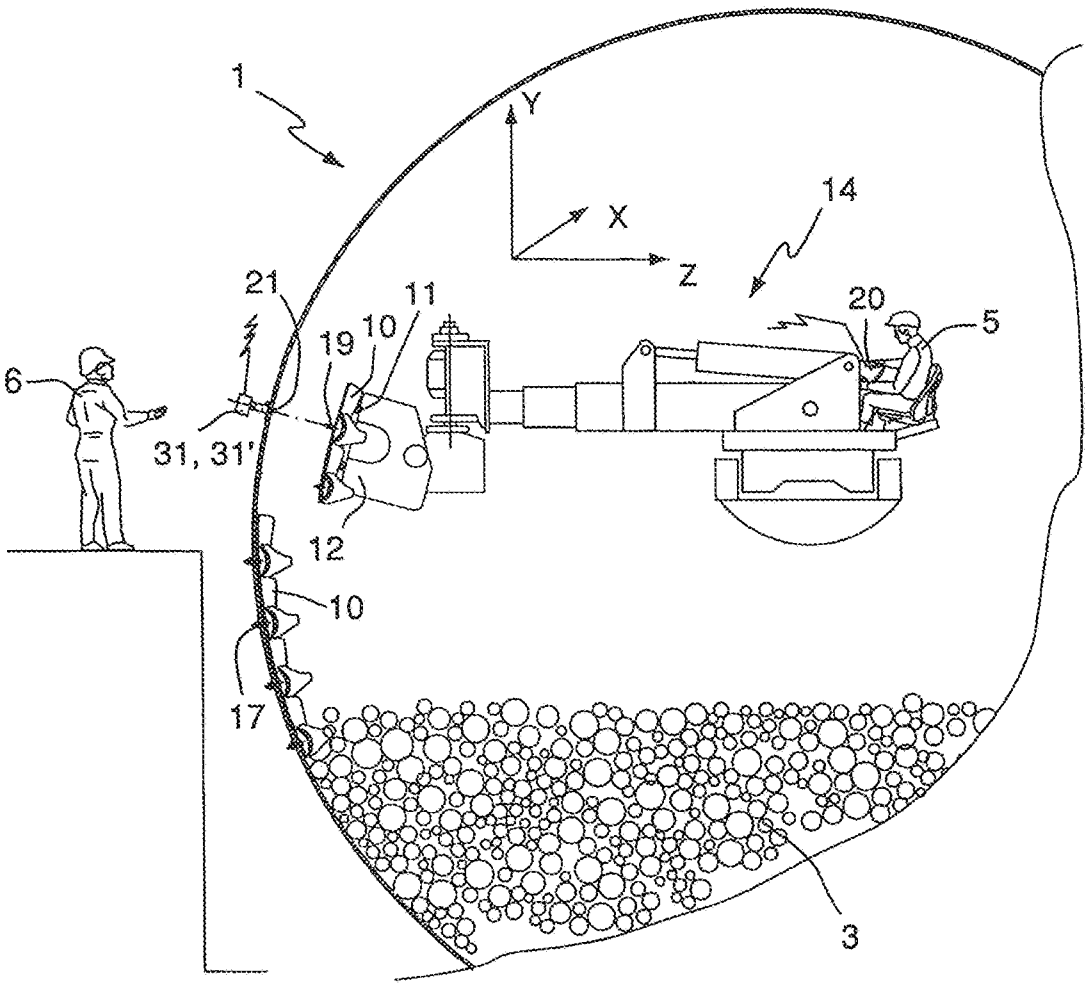
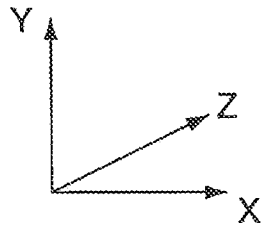


FIG.1



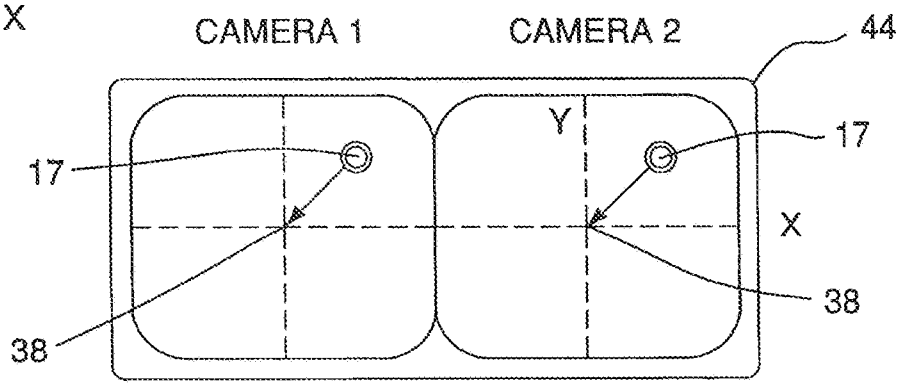


FIG.6a FIG.6b

20152010044 27 Feb 2015

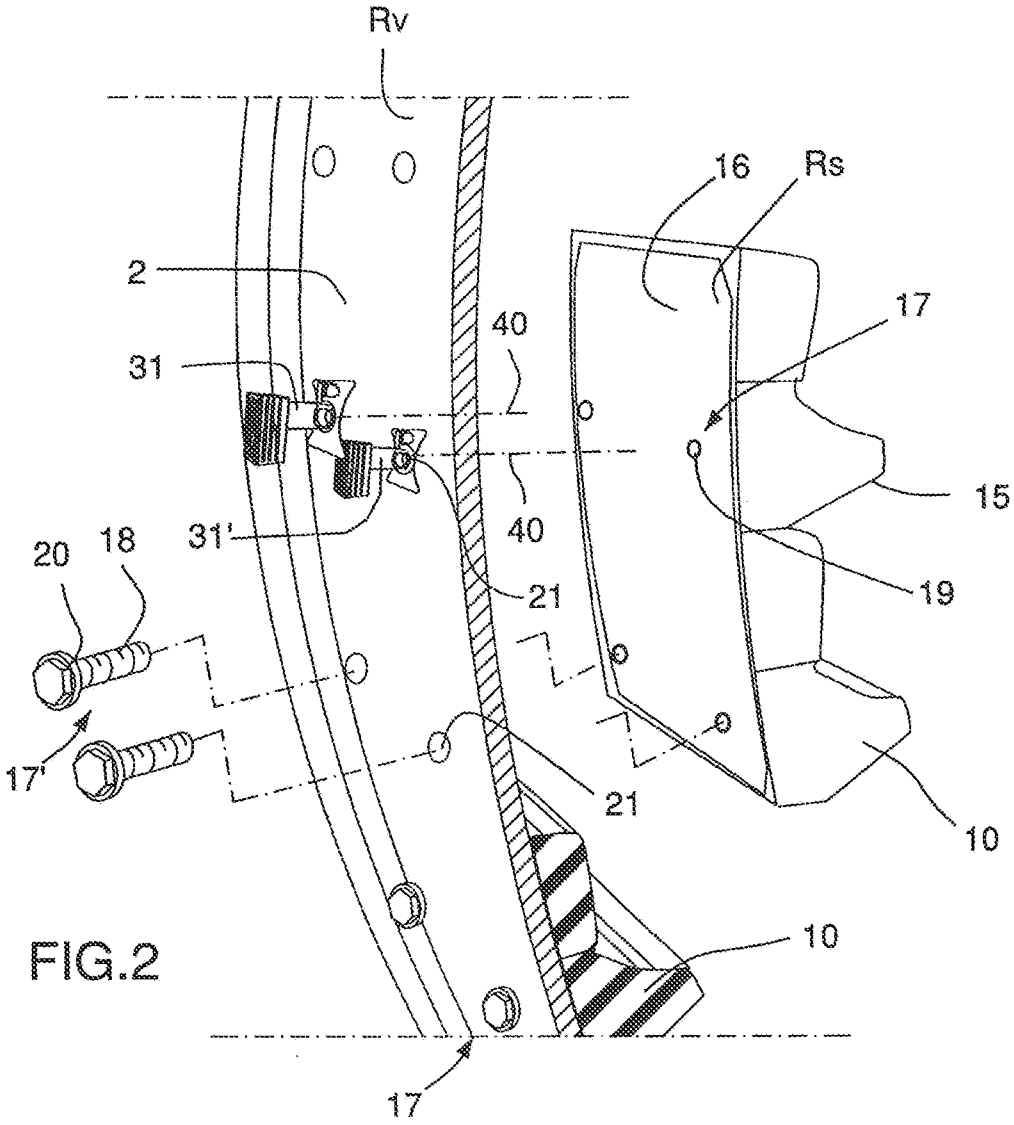


FIG.2

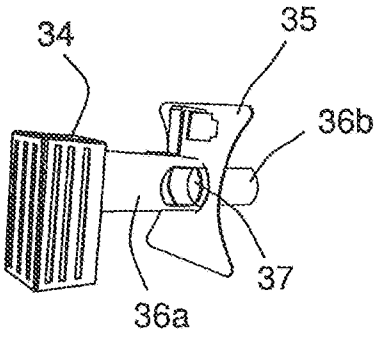


FIG.3

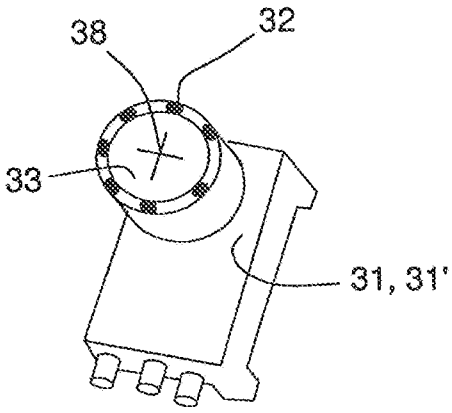


FIG.4

20152010044 27 Feb 2015

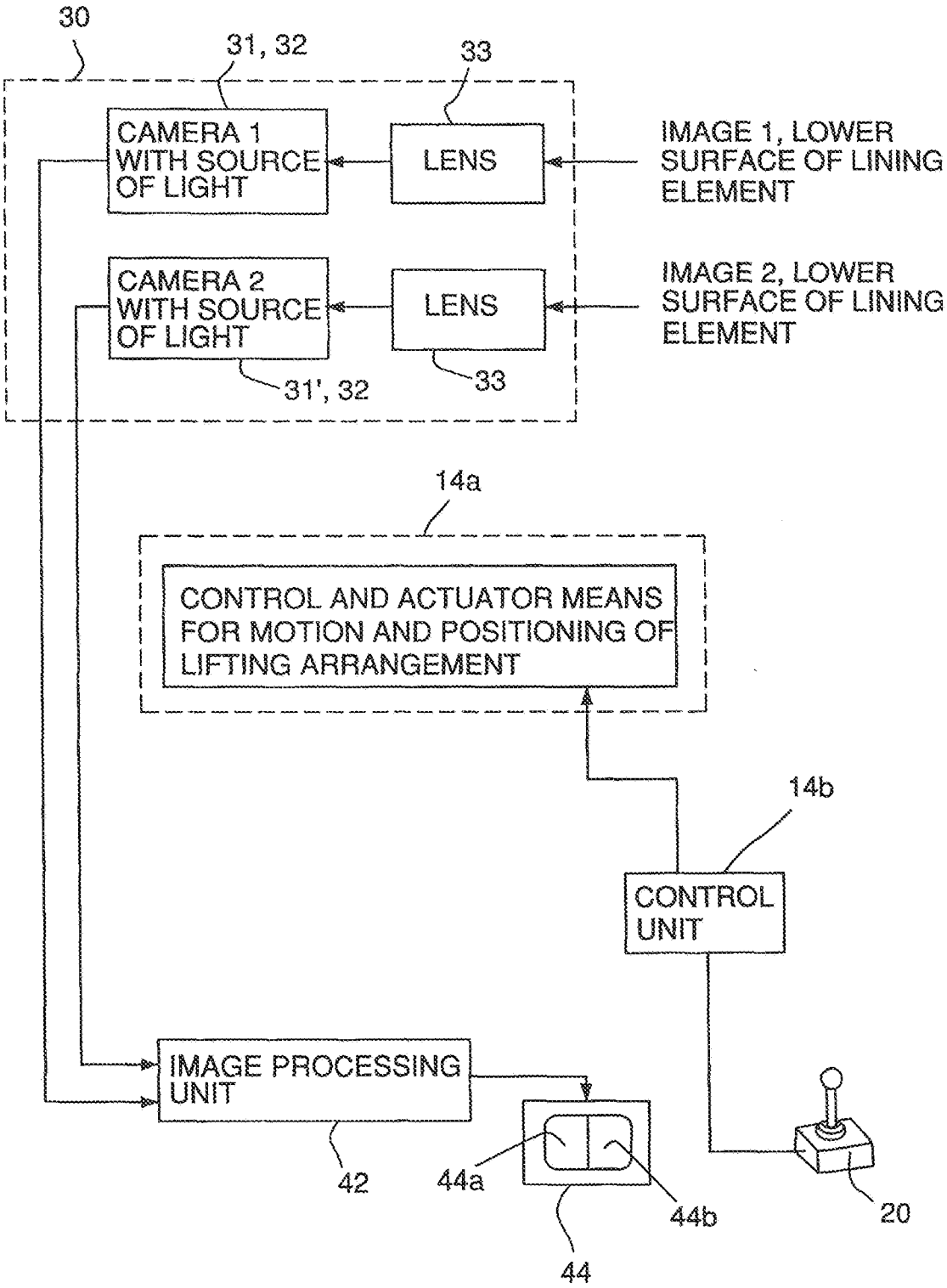


FIG.5

20152010044 27 Feb 2015

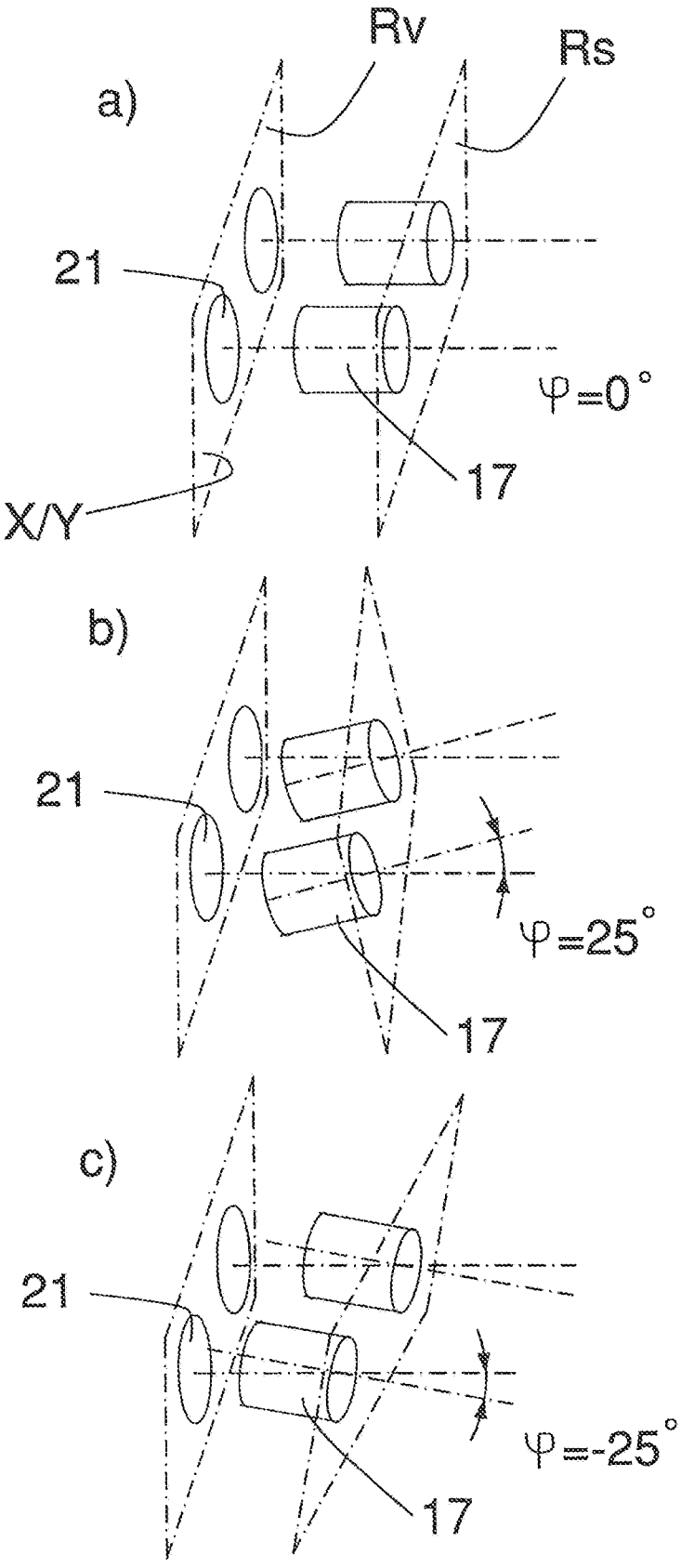


FIG.7

20152010044 27 Feb 2015

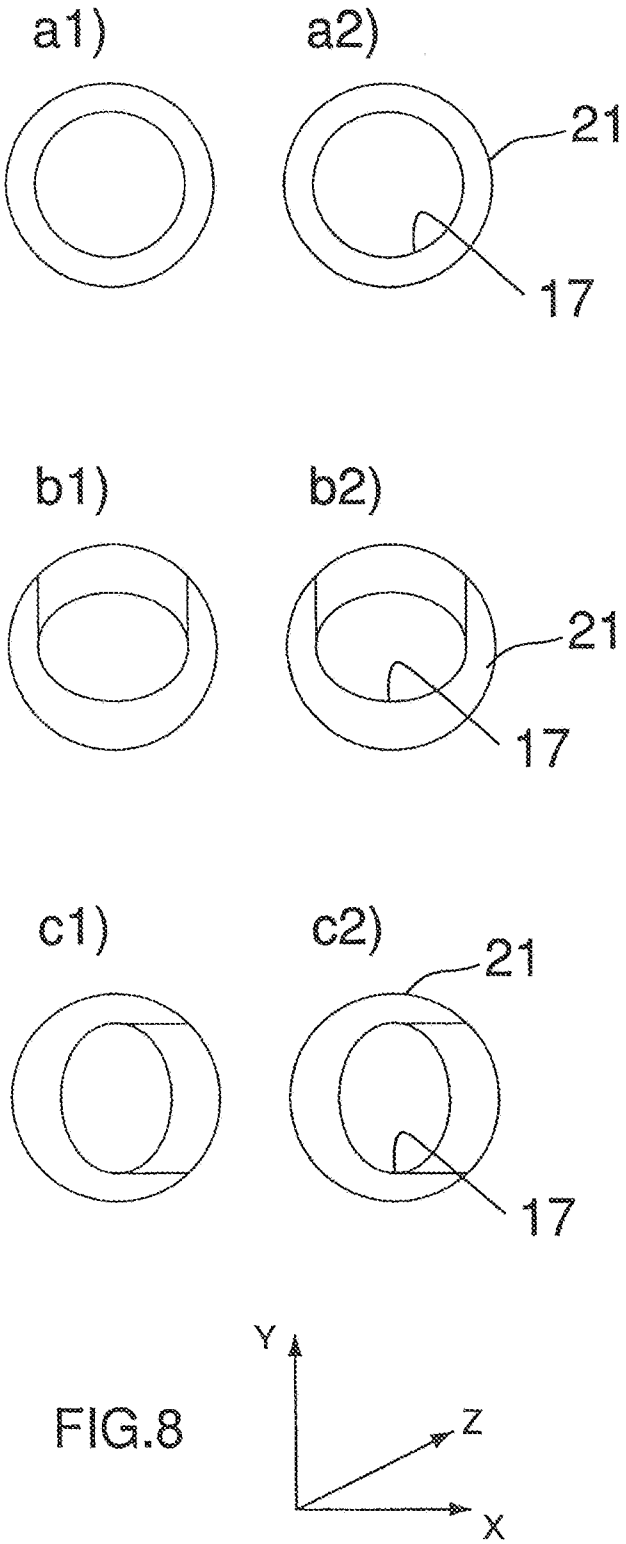


FIG.8

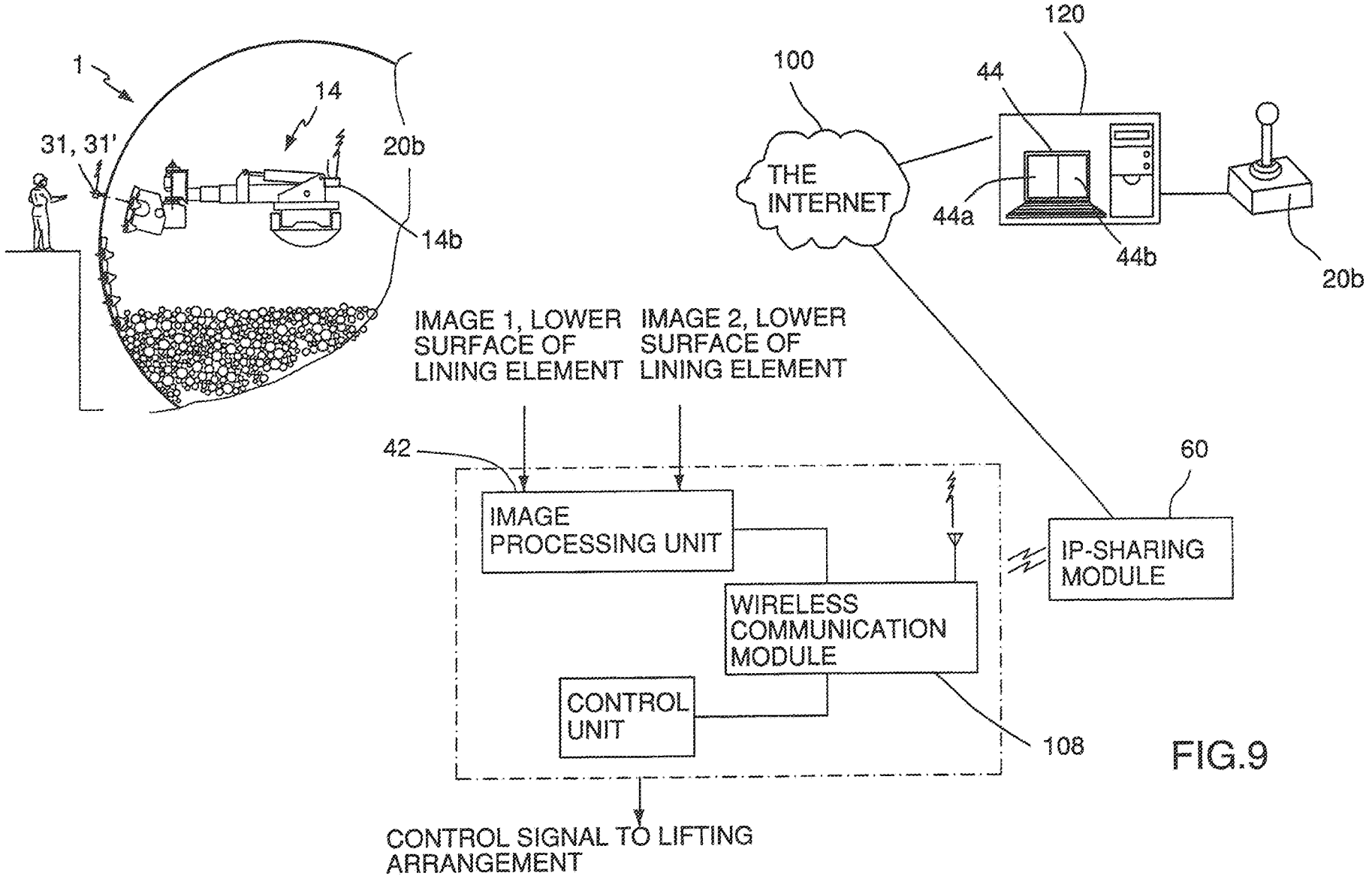

1
14
31, 31'
20b
14b
100
120
44
THE INTERNET
44a
44b
20b
IMAGE 1, LOWER SURFACE OF LINING ELEMENT
IMAGE 2, LOWER SURFACE OF LINING ELEMENT
42
60
IMAGE PROCESSING UNIT
IP-SHARING MODULE
WIRELESS COMMUNICATION MODULE
CONTROL UNIT
108
CONTROL SIGNAL TO LIFTING ARRANGEMENT

FIG.9