(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 October 2008 (16.10.2008)

PCT

(10) International Publication Number
WO 2008/122068 A1

(51) International Patent Classification:
G06F 7/00 (2006.01) *G08B 13/14* (2006.01)

(21) International Application Number:
PCT/AU2007/001299

(22) International Filing Date:
4 September 2007 (04.09.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2007901827 5 April 2007 (05.04.2007) AU

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) **Title:** AN ORE BLOCK MARKER AND A SYSYTEM FOR TRACKING PROGRESSION OF AN ORE THROUGH A PROCESS

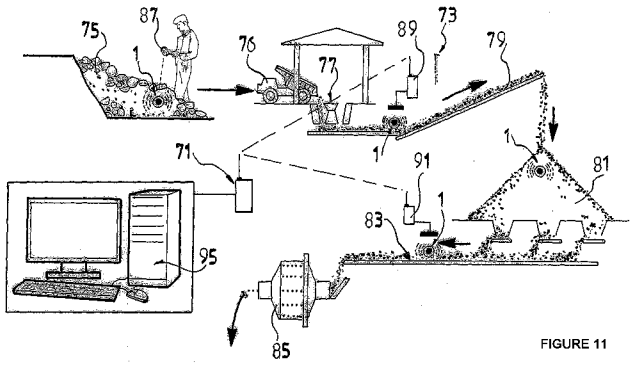

FIGURE 11

(57) **Abstract:** A system (150) for tracking progression of a body of ore blocks that travels along an ore traveling path (154) through a mining process is disclosed. The system includes at least one marker (152) having an onboard storage arrangement (156) for storing unique identification information for the marker which is for placement with the body of ore blocks that is to travel along the ore traveling path (154). The system (150) includes an initial logging arrangement for logging information about an initial instance when the marker (152) is placed with the body of ore blocks and for logging information about an initial position of the body of ore blocks. The system (150) also includes at least one detecting arrangement (158) placed along the ore traveling path (154). Each detecting arrangement (158) is for detecting the at least one marker (152) when it travels through a detection zone. The system (150) also includes a detection logging arrangement for logging information about a detected instance and for logging information about a detected position at which the marker is detected. The system (150) also includes a presenting arrangement (186) for extracting and presenting the logged information about the initial position and the detected position of the marker, thereby to track the progression of the body of ore blocks that travels along the path (154).

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AN ORE BLOCK MARKER AND A SYSYTEM FOR TRACKING PROGRESSION OF AN ORE THROUGH A PROCESS

FIELD OF THE INVENTION

This invention relates to an ore block marker for use with a system for monitoring progression of an ore transported through a mining process. The invention extends to a method of manufacturing a said ore block marker. The invention also extends to a system for tracking progression of a body of ore blocks traveling along an ore travel path. The invention also extends to a method for tracking progression of a body of ore blocks that travels along an ore travel path.

This invention relates particularly but not exclusively to a marker for use in demarcating different sections of an ore body that has been broken into a particulate ore in a mining operation. In particular the marker may be used to measure the movement of different ore blocks due to blasting of the host rock. The marker may also be used to track the progress of different sections of an ore body through a mineral processing plant including a set of conveyor belts and a crusher. It will therefore be convenient to hereinafter describe the invention with reference to this example application. However at the same time it is to be clearly understood that the invention could be used in other applications. For example the marker could be used to track the progress of different sections of an ore body through a process other than that described above. Further the invention could be used to track the travel of different blocks of a rock body that is not an ore body.

BACKGROUND TO THE INVENTION

Mining operations are carried out on a large scale in many parts of the world. Mining involves blasting an ore body within a host rock to break up the ore body and reduce it to a form in which it can be transported away from the blasting site. Subsequent to blasting, the particulate material is processed to separate the valuable mineral from the waste and host rock, e.g. to liberate the valuable mineral. To do this efficaciously the mean size of the particles in the particulate material needs to be reduced. Further the sizes of the different particles need to be made more uniform.

The rock body that has been blasted forms a pile of broken rock that is called a muckpile. This material is recovered from the blast site using a loading vehicle such as a front end loader. The front end loader then tips the broken rock material into a crusher. The crusher acts to reduce the size of the broken rock material to a certain maximum size. The particulate material from the crusher is then transferred by means of a first conveyor belt to an intermediate heap or stockpile. The particulate material is drawn in stages from the stockpile and deposited on a further conveyor belt which transfers it to a SAG mill. The size of the particulate material is reduced further and made more even in the SAG mill. The

mineral processing operations separate the valuable ore from the gangue material and concentrate the valuable product for further processing.

Very often an ore body that is being mined is not homogeneous and the ore body has regions of greater concentration of mineral, e.g. higher grade, than other regions that have lesser grades. Further the minerals within an ore body can vary from one location to another. Prior to blasting mine engineers often have a reasonable three-dimensional geological map of the ore body they are about to blast. This is provided by geologists using techniques that model the ore body based on experimental data. These models produce reasonable maps of the boundaries of the ore blocks within the unbroken rock body. However an important point to bear in mind is that these models map the boundaries of the ore blocks in the host rock that has not yet been blasted.

Many current mining practices assume that there is no movement of the ore boundaries as a result of blasting the rock body to break it up. However experimental work done by the Applicant shows that the rock does move very significantly and profoundly as a result of the blast. In fact Applicant has found that the rock body moves by several meters as a result of the blast and different regions or portions of the rock body move by different amounts. An inevitable result of this is that ore dilution is prone to occur. Ore dilution is when valuable ore is sent to the tailings dump and is thus not recovered as metal in the mining process. In addition this also leads to waste rock being directed to the processing plant for processing with the ore.

Clearly therefore it would be advantageous if a system or method could be devised to help measure the movement in different sections of a rock body as a result of blasting the rock. This would enable mining operators to adjust the three dimensional maps they have of the ore blocks within the unbroken host rock to take into account movement of the rock as a result of blasting. This in turn would help to reduce dilution of complex ores due to this movement. In turn this should lead to improved volumes of valuable ore being produced by the processing plant and this in turn should lead to increased volumes of valuable metal being produced.

Further with current mining practices many mines have no tools whatsoever to help them determine when different blocks of ore within a host rock are being processed in a processing plant. Put another way there are no tools or techniques to track the progress of the different ore blocks as defined in the original geological map of the host rock through the different unit operations of a plant such as crushing and milling.

As a general proposition the ore blocks are generally visually indistinguishable from each other as they

pass through the plant. While the material may be visible as it travels along a conveyor belt this in itself is not helpful. This situation is exacerbated by the fact that very often a mine will have an intermediate heap onto which particulate material is discharged in between the crusher and the SAG mill. This introduces another level of complexity into any effort to understand when different parcels or blocks of ore are being processed in say the SAG mill. This is sub-optimal, if not downright inefficient, as different ore blocks have different particle breakage properties. It thus reduces the accuracy and/or quality of the simulation of the processing of the ore through the crusher and the mill, e.g. the SAG mill.

Applicant is aware that a few mines may have well instrumented dispatch systems and these dispatch systems may help operators to predict when a certain ore body is being processed by the crusher and mills. However when ore blending is conducted at the site the ore block sequence gleaned from the dispatch system is altered and this adds another dimension of complexity. Thus even in the case where a mine has a well developed dispatch system it is still difficult to determine when a specific parcel or ore or a specific ore block is being processed.

Clearly therefore it would be advantageous if a method and/or apparatus could be devised for tracking a block or parcel of ore from the mine site along the conveyor belts to the crusher, through the crusher, through the further conveyor belts leading to the mills, and then through the mill. This would help to improve simulation of the operation of the mineral processing plant and this in turn would lead to better operation of the plants. In view of the increasing cost of energy and the scarcity of energy there is a strong imperative to improve the efficiency and performance of crushers and mills. There is also an economic imperative to maximize the recovery of valuable mineral from any given ore body and thereby maximize the monetary value of the product that is produced.

SUMMARY OF THE INVENTION

According to one aspect of this invention there is provided a system for tracking progression of a body of ore blocks that travels along an ore traveling path through a process, which system includes:

at least one marker having an onboard storage arrangement for storing unique identification information for the marker, each marker being for placement within the body of ore blocks that is to travel along the ore traveling path through the process;

an initial logging arrangement for logging information about an initial instance when the marker is placed with the body of ore blocks and for logging information about an initial position of the body of ore blocks;

at least one detecting arrangement placed along the ore traveling path at an detection zone defining a detection position, each detecting arrangement being for detecting the at least one marker when it travels within the body of ore through the detection zone;

a detection logging arrangement for logging information about a detected instance when the at least one marker is detected by the detecting arrangement and for logging information about a detected position at which the marker is detected by the detecting arrangement;

a presenting arrangement for extracting and presenting the logged information about the initial instance and the detected instance of the marker, and for presenting the logged information about the initial position and the detected position of the marker, thereby to track the progression of the body of ore blocks that travels along the ore traveling path through the process.

The marker may include a capsule having an interior, and the capsule may include a robust outer wall for shielding the onboard storage arrangement from the body of ore blocks with which it travels along the ore travel path.

The detecting arrangement may include an interrogating arrangement for continuously interrogating the detection zone for detecting the at least one marker when it travels with the body of ore blocks through the detection zone.

The marker may include an announcing arrangement for announcing the presence of the marker within the detection zone when interrogated by the detecting arrangement as the marker travels with the body of ore through the detection zone. The announcing arrangement may include a transponder that is responsive to the interrogating arrangement, the transponder being in communication with the information storage arrangement for transmitting the unique identification information of the marker to the detecting arrangement in response to interrogation from the interrogating arrangement.

The transponder and storage arrangement may be a radio frequency identification (RFID) tag and the interrogating arrangement includes a RFID reader device.

The at least one marker may in fact comprise a plurality of said markers, e.g. for placement within the body of ore blocks that is to travel along the ore traveling path though the mining process. Each marker may have an onboard storage arrangement for storing its unique identification information.

Some of the plurality of markers may be placed within one type of body of ore blocks and others of the plurality of markers may be placed within another type of body of ore blocks.

The system may include a computer apparatus having a computer database and a computer network interfacing arrangement.

Each detecting arrangement may include a terminal network interfacing arrangement for establishing communication over a wireless data communication network with the computer network interfacing arrangement.

The initial logging arrangement may include a transportable detecting apparatus that is transportable to a relevant marker for interrogating the relevant marker so that the relevant marker announces its unique identification information to the transportable detecting apparatus. The initial logging arrangement may include a geographic location determining apparatus for determining the position of the relative marker along the ore traveling path.

The transportable detecting apparatus may include a transportable database for storing the identification information of the relevant marker and the geographic location of the relevant marker.

The transportable detecting apparatus may include a time stamping arrangement for generating time and date information at the instant at which the transportable detecting apparatus receives the identification information from the relevant marker. The transportable detecting apparatus populates the transportable database with the associated identification information of the relevant marker, information about its determined position, and information about the generated time and date.

The transportable detecting apparatus and the computer apparatus may include a data communication interfacing arrangement for downloading the initial information from the transportable detecting apparatus to the computer apparatus, so that the computer apparatus populates the computer database with the downloaded initial information.

Each detecting arrangement may be a stationary detecting arrangement and may include a terminal network interfacing arrangement for connection in communication over a wireless data communication network with the computer network interfacing arrangement.

The detection logging arrangement may include a stationary database at each stationary detecting arrangement. Each stationary database may be for storing the identification information of a maker that is detected when traveling with the body of ore through its associated detection zone.

The computer data communication interfacing arrangement may be for downloading the identification information from each stationary database to the computer apparatus, and for downloading a unique

identification point address of the stationary detecting arrangement, so that the computer apparatus populates the computer database with the downloaded unique identification information of the marker that passed through the detecting zone and with the associated unique detecting arrangement address.

The stationary detecting arrangement may include a time stamping arrangement for generating time and date information at the instant at which the stationary detecting arrangement receives the identification information from the marker passing through its associated detection zone. The computer apparatus may populate the computer database with information of the address of each stationary detecting arrangement, the identification information of the detected markers passing thought detection zone of each stationary detecting arrangement, and the generated time stamp for each marker.

The computer apparatus may include the presenting arrangement for comparing the initial time stamp of each marker with its detected time stamps, and for comparing the initial position of each marker with its detected position, and for populating the computer database for each marker with its compared information, thereby to determine the detecting points that the markers, and hence the body of ore blocks, have passed and the time that has elapsed until the markers passed the detecting points.

The computer apparatus may include a user interface for presenting the populated information in the computer database to the user, and also include a setup arrangement for setting the stationary detecting arrangements and the associated locations and address identification information of each stationary detecting arrangement on the computer database. The computer apparatus may include an internet network interface for remotely accessing the computer apparatus over the internet.

According to another aspect of this invention there is provided a method for tracking progression of a body of ore blocks that travels along an ore traveling path through a mining process, which method includes:

placing at least one marker within the body of ore blocks that is to travel along the ore traveling path though the mining process, each marker having a unique identification information stored in an onboard storage arrangement of the marker;

logging an initial instance and an initial position of the body of ore blocks with an initial logging arrangement;

placing at least one detecting arrangement along the ore traveling path at a detection zone defining a detection position, and detecting the at least one marker when it travels with the body of ore through the detection zone;

logging the detection instance and the detection position when the at least one marker is detected by the detecting arrangement; and

comparing the initial and the detection instances with each other, and comparing the initial position and the detection position with each other with a presenting arrangement, thereby to track the progression of the body of ore blocks that travels along the ore traveling path through the mining process.

Placing at least one marker may include placing a capsule within the body of ore blocks, the capsule having an interior and an outer robust wall for shielding the onboard storage arrangement from the body of ore blocks with which it travels along the ore traveling path

The method may include continuously interrogating the detection zone with the detecting arrangement having an interrogating arrangement for detecting the at least one marker when it travels with the body of ore blocks through the detection zone. The method may also include providing the marker with an announcing arrangement for announcing the presence of the marker within the detection zone when interrogated by the detecting arrangement as the marker travels with the body of ore through the detection zone. The announcing arrangement may include a transponder responsive to the interrogating arrangement, the transponder being in communication with the information storage arrangement, and the method may include transmitting the unique identification information to the detecting arrangement in response to interrogation from the interrogating arrangement.

The method may include providing the transponder and the storage arrangement onboard the marker by providing a marker with a radio frequency identification (RFID) tag inside the marker. The method may include providing the interrogating arrangement with a RFID reader device.

The method may include providing a plurality of said markers, each marker having an onboard storage arrangement for storing unique identification information, and the method may include placing a plurality of markers within the body of ore blocks that is to travel along the ore traveling path though the mining process.

The method may include placing some of the plurality of markers within one type of body of ore blocks and placing some other markers within another type of body of ore blocks.

The method may include providing a computer apparatus having an information database and a computer network interfacing arrangement. The method may also include providing each detecting arrangement with a terminal network interfacing arrangement and establishing a connection between the detecting arrangement and the computer network interfacing arrangement over a wireless data communication network.

The method may include providing the initial logging arrangement with a transportable detecting apparatus that is transportable to a relevant marker and interrogating the relevant marker so that the relevant marker announces its unique identification information to the transportable detecting apparatus, and providing the initial logging arrangement with a geographic location determining apparatus and determining the initial position of the relevant marker along the ore traveling path.

The method may also include providing the transportable detecting apparatus with a transportable database and storing the identification information of the relevant marker and the geographic location of the relevant marker in the transportable database. The method may also include providing the transportable detecting apparatus with a time stamping arrangement and generating time and date information at the instant at which the transportable detecting apparatus receives the identification information from the relevant marker.

The method may include populating the transportable database with the associated identification information of the relevant marker, including its determined position, and the generated time stamp.

The method may include providing the transportable reader and the computer apparatus with a data communication interfacing arrangement and downloading the information form the transportable reader to the computer apparatus, and populating the computer database with the downloaded initial information.

The method may include providing each detecting arrangement with a terminal network interfacing arrangement and establishing a connection between the computer network interfacing arrangement and each one of the terminal network interfacing arrangements over a wireless data communication network.

The method may include providing each detecting logging arrangement with a stationary database and storing in each stationary database the identification information of a maker that is detected when traveling with the body of ore through the detection zone of the detecting arrangement.

The method may include downloading the identification information of each marker from each stationary database to the computer, and downloading a unique identification point address of the detecting arrangement, and populating the computer database with the downloaded unique identification information of each marker passing through the detecting zone and with the associated unique detecting arrangement address.

The method may also include providing the detecting arrangement with a time stamping arrangement for generating time and date information at the instant at which the detecting arrangement receives the identification information from the marker passing through the detection zone.

The method may also include populating the computer database with the associated identification information of each one of the detected markers, and information about the position of the detecting arrangement, and the generated time stamp.

The method may include providing the presenting arrangement with the computer apparatus and comparing for each marker its initial time stamp with its detected time stamp, and comparing for each marker its initial position with its detecting positions, and populating the computer database for each marker with the unique addresses of the detecting points that it has passed and the time taken for the marker to pass between the detecting points.

The method may include providing the computer apparatus with a user interface and presenting the information in the computer database to the user, and with a setup arrangement and setting the detecting arrangements and for storing the associated location and address identification information in the computer database. The method may further include providing the computer apparatus with an internet network interface and remotely accessing the computer apparatus over the internet.

The method may include placing at least one marker within a muck pile of ore blocks at a mine, and installing stationary detecting arrangements along an ore traveling path, and may include placing the stationary detecting arrangement at spaced intervals along a conveyor system at a mine. The method may also include placing at least one marker within a stockpile of ore blocks, and installing stationary detecting arrangements along a process plant ore traveling path, e.g. along a conveyor belt system at the process plant. The method may also include installing stationary detecting arrangements before a primary crusher plant section, before a secondary crusher plant section, and before an ore mill section.

According to another aspect of this invention there is provided an ore block marker for use with a system for monitoring progression of a body of ore blocks transported through a mining process, the ore block marker including:

a marker body; and

a transponder mounted or mountable within the marker body,

the marker body and the transponder when mounted within the marker body being for placement with the body of ore blocks and being detectable by the system as it passes thought the

mining process along with the body of ore blocks, thereby to monitor progression of the body of ore blocks through the mining process.

The marker body may include a robust outer sidewall defining an interior cavity within which the transponder is mounted. The outer sidewall may define opposed major end walls and a minor sidewall extending between the end walls, and the outer wall may tend to come to rest on its major end walls, e.g. it may have a shape and a size that encourages this. The outer sidewall may be shaped and sized to form a close-ended shallow circular cylindrical body having major end walls in the form of two opposed generally circular end walls and a shallow cylindrical sidewall extending between the end walls and merging with the end walls to form rounded circumferential edges at the transition.

The edges of the body around the circumference of the major surfaces may be rounded. Thus the body may not have sharp edges where it transitions from the circular major surfaces to the cylindrical wall.

Thus the transponder may be mounted on the internal mounting within the interior space within the body. The transponder may be at least partially surrounded by air which assists in damping or attenuating blast energy that impacts the body before it reaches the transponder within the body.

Thus the marker body may be shaped and sized so that when it is placed within a body of ore blocks it moves with the body of ore blocks without significant segregation due to size.

For example the marker may have a specific gravity correspond broadly to a gross mean specific gravity of the body of ore blocks within which it is to be pleased, in use. For example the tags may be arranged to have an SG in the range of 1.5-3.5, e.g. 2.0-3.0.

The circular cylindrical body may have a diameter of between 3 cm and 10 cm, e.g. a diameter of 5 cm to 8 cm, and a depth of between 2 cm and 4 cm. The housing should preferably be sized that when it is received within a body of particulate material it moves with the particulate material without significant segregation due to size.

The marker body may include at least one mounting formation in the interior of the marker body, the mounting formation being for mounting the transponder inside the interior of the marker body.

The marker body may include an inner wall inside the interior of the marker body, the inner wall being spaced in from the outer wall, e.g. in a radial direction, so that a gap is defined between the inner wall and outer wall. The inner wall may be a circular cylindrical inner wall extended concentrically between the two end walls, and the inner wall may define a cavity within which the transponder is mountable.

The transponder may include a storage for storing identification information unique to the transponder, and the transponder may be capable of transmitting the identification information to a receiver device forming part of the system. The transponder may be a radio frequency identification (RFID) tag and the RFID tag may be any one of a passive RFID tag and a active RFID tag.

By passive tag is meant that the tag does not contain its own energy source. Rather it is energized by a signal it receives from a reader. An active tag contains its own energy supply and does not rely on receiving energy from a reader.

The marker may include a body protecting material and the RFID tag may be embedded in the body protecting material. In particular the body protecting material may be shaped and sized to fit snugly inside the cavity defined by the inner wall.

The body protecting material may have a shape in the form of a flattened cylindrical body. That is the cylindrical body has two major surfaces of substantially circular configuration and a cylindrical wall of relatively short lineal extent.

The body protecting material may have a diameter of 25-60mm and a depth or height of 10-20mm.

The RFID tag may be mounted within the body with an orientation so that its area of greatest flux is exposed for the reader when the marker body orientates itself onto its major surface. That is its area of greatest flux may be oriented parallel to the major surface of the body. To achieve this the RFID tag is orientated within the body so that its area of greatest flux is orientated in an upwardly facing direction. This positions the tag so that it has the best chance of being read by a tag reader when it passes the tag reader.

The marker body may include two body parts that are attachable to each other to form the marker body once the tag mounted on one of the body parts. The body parts may be attached to each other by means of complementary clip formations.

Each body part may include a said mounting formation and the RFID tag may be clamped tightly between the two mounting formations when the housing parts are attached to each other.

The marker body may be formed from a synthetic material, e.g. a strong and robust synthetic material. In one form the body may be formed from NYLON TM filled with glass fibre. The outer wall of the marker body may have a thickness of between 3 and 8 mm.

The body parts may be formed by a molding operation. Conveniently the body parts may be formed from the same mold. The clips may be integrally formed with the body parts.

According to another aspect of this invention there is provided a method of manufacturing an ore block marker for use with a system for monitoring progression of a body of ore blocks transported through a mining process, the method including:

forming a marker body having an interior; and

mounting a transponder within the interior of the marker body,

the marker body and the transponder when mounted within the marker body being for placement with the body of ore blocks and being detectable by the system as it passes thought the mining process along with the body of ore blocks.

Forming the marker body may include forming a robust outer sidewall for the marker body defining an interior cavity within which the transponder is mounted. The method may include shaping and sizing the outer sidewall so that it defines opposed major end walls and a minor sidewall extending between the end walls to encourage the marker to rest on its major end walls. The method may further include shaping and sizing the outer sidewall so that it forms a close-ended shallow circular cylindrical body having two opposed generally circular end walls and a shallow cylindrical sidewall extending between the end walls and merging with the end walls to form rounded circumferential edges at the transition.

The method may include shaping and sizing the marker body so that when it is placed within a body of ore blocks it moves with the body of ore blocks without significant segregation due to size. The method may also include forming the marker so that it has a specific gravity corresponding broadly to a gross mean specific gravity of the body of ore blocks within which it is to be placed, in use, e.g. a specific gravity of between 1.5 and 3.0.

The circular cylindrical body may be shaped and sized to have a diameter of between 3 cm and 10 cm. The method may also include forming the marker body so that it has a depth of between 2 cm and 4 cm. The method may include forming at least one mounting formation in the interior of the marker body, the mounting formation being for mounting the transponder inside the interior of the marker body.

The method may include forming an inner wall inside the interior of the marker body, and spacing the inner wall inside the interior of the marker body away from the outer wall, so that a gap is defined between the inner wall and outer wall. The method may include forming a circular cylindrical inner

wall extending concentrically between the two end walls, the inner wall defining a cavity in which the transponder is mountable.

The method may include providing a transponder having a storage for storing identification information unique to the transponder, and being capable of transmitting the identification information to a receiver device forming part of the system. The transponder may be provided in the form of a radio frequency identification (RFID) tag, e.g. a passive RFID tag or an active RFID tag.

The method may include embedding the RFID tag within a body of protective material, and shaping the body of protective material snugly to fit inside the cavity defined by the inner wall. The method may include mounting the RFID tag within the body so that its area of greatest flux is exposed for the reader when the marker body orientates itself onto its major surface.

Forming the marker body may include forming two body parts that are attachable to each other to form the marker body once the tag is mounted on one of the body parts. Forming may also include forming complementary clip and clip receiver holes on the body parts, so that they are attachable to each other.

The method may include forming mounting formations inside an interior of each body part, and mounting the RFID tag in position by clamping it tightly between the two mounting formations when the housing parts are attached to each other.

The method may include forming the marker body from a synthetic material, e.g. by a molding operation and with an outer wall having a thickness of between 3 and 8 mm. The method may include forming the clip formations integrally with the body parts with the same mold.

According to another aspect of the invention there is provided an apparatus for tracking the displacement of a block of ore on blasting and/or the movement of a block of ore through a plant, the apparatus comprising:

at least one marker as described above according to a preceding aspect of the invention; and

at least one reader for reading the marker/s when they come within a reading range of the reader.

The marker may include any one or more of the optional features of the marker described above according to the first aspect of the invention.

The apparatus may include at least one reader that is a stationary reader. Each stationary reader may be positioned at a certain point along a path taken by the particulate material and the reader reads the tags

as they pass this point mixed up with the particulate material being treated in the plant. The stationary reader reads the identity of each tag that passes by and also records the time at which it reads the tag.

The reader may comprise an antenna and the antenna may comprise a flattened antenna body having two major surfaces. The major surfaces may be arranged with a horizontally extending orientation and thereby direct radio energy perpendicularly away from the major surfaces in a direction towards the path along which the marker moves.

The major surface of the reader may be substantially parallel to the major surface of the tag to maximise the electromagnetic energy flux passing between the reader and tag. This increases the likelihood that the reader will read the tag when it passes in proximity thereto, e.g. within radio wave range of the reader. The reader may read tags passing within a range of 0.25 to 5m of the reader provided that the orientation of the marker is horizontally extending as described above such as to maximize the flux passing between the antenna and the tag.

The apparatus may also include a transportable reader, e.g. that is hand held and is carried about by a user. The hand held reader may include an antenna and the hand held reader may also include a location identifier, e.g. a GPS based location reader.

The transportable reader may be used to log the identity and the positions on the markers on the initial pile of broken rock material before the particulate material is discharged into the plant. The transportable reader may also be used to log the identity and position of the markers across the rock body before it is blasted.

According to another aspect of this invention there is provided a method of measuring movement of component portions of a three dimensional ore body through a mineral processing plant, the method comprising:

placing a plurality of markers into different regions of a particulate material prior to it being loaded onto a conveyor belt;

logging the identity and location of each marker using a portable reader having location determining means; and

reading the identity of each of the markers when they pass by each reader located at specific points along the path taken by material passing through the plant.

The method may include logging the time when each of the markers is read by the readers located at specific points along the path through the point.

The method may include transferring the data collected by the hand held and stationary readers to a data collection means.

The method may include determining when different blocks of ore are being processed through different unit operations in the plant based on the information on the markers that is read by the readers and sent to the data collection means.

The first step of placing above may include placing the markers onto the surface of a broken up body of rock that has been blasted in a mining operation. The markers may be placed on the broken rock, e.g. the muck pile, at locations that are spaced apart from each other.

The method may include reading the tags by means of readers located at two or more specific points along the path taken by material passing through the plant. The method may include reading the tags just downstream of a crusher. That is one reader may be located downstream of a crusher, e.g. adjacent a crusher and downstream thereof but upstream of an intermediate heap. The method may also include reading the tags just upstream of a mill. That is another reader may be located upstream of a mill, such as adjacent to and upstream of a mill, e.g. downstream of an intermediate heap and upstream of the mill. Thus the markers can be read at two spaced locations along the length of the plant prior to the mill.

The method may also include a further step carried out prior to the other steps of placing the markers within the body of rock and logging their positions prior to blasting of the rock. Naturally this step would occur prior to the step of logging the position of the markers in the broken particulate material prior to blasting.

Thus in some forms of the invention the markers are placed in explosives holes and the position of these same markers is then logged after the blast on the muckpile and then the time when these markers pass through different portions on the plant is also logged.

According to another aspect of this invention there is provided an apparatus or system for tracking the displacement of a block of ore on blasting and/or the movement of a block of ore through a plant including a crusher, a first conveyor, an intermediate heap, a second conveyor, and a mill, the apparatus comprising:

a plurality of markers as described above according to the first aspect of the invention for being positioned within the broken ore material in a plurality of different positions prior to it being placed on a conveyor belt;

a hand held reader for reading the tags on the broken rock body and logging their identification and their surface location;

a first stationary reader positioned above the first conveyor for reading the tags when they travel along the first conveyor and logging their identification and the time that they were read;

a second stationary reader positioned above the second conveyor for reading the tags when they travel along the second conveyor and logging their identification and the time that they were read; and

a data collection means for collecting and organising the information on the markers read by the first and second readers.

The markers may include any one or more of the optional features of the markers of the first aspect of the invention. The stationary readers may include any one or more of the features of the readers defined in the second aspect of the invention described above. The hand held reader may be carried about by a user and may include any one or more of the optional features of the hand held reader described in the second aspect of the invention.

According to another aspect of this invention there is provided a method of measuring the movement of boundaries of ore blocks within an ore body as a result of blasting, the method comprising:

placing one or more markers including a transponder into an ore body at one or more locations prior to a blast;

logging the location of the marker/s prior to a blast by means of a reader that interacts with the marker; and

logging the markers after the blast.

The step of logging the markers after the blast may comprise logging the time at which the markers pass through the crusher and using the mine dispatch system to back calculate where the tag was excavated from.

Thus the markers indicate the position of certain parts of a rock body when it is still intact prior to a blast and also the location of these same parts after the blast. As such it helps to indicate the extent of the displacement of ore blocks and the like as a result of the blasting action. This method helps mine operators to reduce ore dilution which is when valuable ore is lost and some waste rock is sent through the concentrator.

Put another way it enables the displacement and translational movement of the various parts or blocks of the rock body as a result of the blast to be measured and taken into account. It is well recognized that such movement does take place and that it is different for different parts of the rock body.

The step of placing may include placing a plurality of markers into the ore body at spaced locations across the surface of the ore body. The step of placing may include placing at least some of the markers within holes drilled into the ore body from the surface thereof. The markers may be placed within holes in the ore body in which the explosives are placed, e.g. blast stemming holes. The markers may be positioned a distance beneath the surface within these holes. The holes may be packed with a packing material after the explosives and markers have been placed in the holes.

The construction of the markers as defined above in the first aspect of the invention has the effect that markers have a good chance, in excess of 50%, of surviving the blast when placed in the same blast hole as the explosives. Thus while there will be some attrition of the markers it will not be sufficiently great to destroy the efficacy of the method using the markers for this purpose.

The location/s of the markers may be logged with one or more hand held readers. Each hand held reader may be carried about by a user and may include any one or more of the optional features of the hand held reader described in the second aspect of the invention.

The invention also extends to a mineral processing apparatus including the apparatus defined above in the second aspect of the invention. The mineral processing apparatus may include a crusher and a mill and one or more conveyor belts.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An ore block marker and a system for tracking progression of an ore traveling along an ore traveled path using the ore block markers in accordance with this invention may manifest itself in a variety of forms. It will be convenient to hereinafter describe at least two embodiments of the invention in detail with reference to the accompanying drawings. The purpose of providing this detailed description is to instruct persons having an interest in the subject matter of the invention how to carry the invention into practical effect. However it is to be clearly understood that the specific nature of this detailed description does not supersede the generality of the preceding broad description. In the drawings:

Fig. 1 is an upper three dimensional view of a marker in accordance with one embodiment of the invention;

Fig. 2 is an exploded three dimensional view of the marker of Fig. 1 showing the structure of the housing for the marker and also the tag within the housing;

Fig. 3 is a sectional front view of the marker of Fig. 1 showing the housing and the tag located within the housing;

Fig. 4 is a schematic drawing of components of an apparatus in accordance with the invention comprising the marker shown in Fig. 1 and a reader for reading the marker;

Fig. 5 is a schematic drawing of an apparatus in accordance with one embodiment of the invention;

Fig. 6 is a schematic sectional end elevation of the apparatus of Fig. 5 showing a reader positioned above a conveyor belt carrying particulate material with the markers being carried along with the particulate material;

Fig. 7 is an upper three dimensional view of a hand held reader for the apparatus of Fig. 5;

Fig. 8 is a schematic drawing showing an example of the information captured on a screen of a data collection means of the apparatus in Fig. 5;

Fig. 9 is a three dimensional view of a marker being inserted into a blast hole prior to carrying out a blast;

Fig. 10 is a schematic plan view showing the positions of an example set of markers prior to a blast and also showing the positions of the same set of markers after the blast;

Fig. 11 is a schematic flow sheet of an apparatus in accordance with another embodiment of the invention for tracking the passage of different ore blocks from a rock body through a mineral processing plant, up to the mill of the plant;

Fig. 12 is a schematic front elevation of a conveyor belt showing a plurality of markers along the length of the conveyor belt delineating various ore blocks within the ore body that is being processed; and

Fig 13 is a functional block schematic diagram of a system, in accordance with the invention, for tracking progression of a body of ore blocks that travels along an ore traveling path.

In Fig. 13, reference numeral 150 refer generally to a system, in accordance with the invention, for tracking progression of a body of ore blocks that travels along an ore traveling path 154 through a mining process. Fig. 13 is a schematic functional block-type diagram showing the system conceptually.

The system 150 includes at least one marker 152 that is placed within a body of ore blocks that is to be tracked along the ore traveling path 154. The marker 152 includes an onboard storage arrangement 156 for storing unique identification information for the marker 152.

At least one detecting arrangement, generally indicated by reference numeral 158, is placed along the ore traveling path 154 at a detection zone defining a detection position. Each detecting arrangement 158 is for detecting the marker 152 when it travels with the body of ore through the detection zone.

The marker 152 includes a capsule having an interior in which a transponder 162 is mounted, as is explained in more detail below. The capsule includes a robust outer wall for shielding the onboard storage arrangement 156 and the transponder 162 from damage that may be inflicted by the body of ore blocks or particulate ore material that entrain the marker. The transponder 162 is in the form of a radio frequency identification (RFID) tag and has unique identification information stored thereon.

In this example, the detecting arrangement 158 includes an interrogating arrangement 164 in the form of an RFID reader device for continuously interrogating the detection zone for detecting marker 150 when it travels with the body of ore blocks through the detection zone.

A user may place more than one marker 152 within a body of ore blocks or particulate ore material, herein after referred to as an ore parcel, to enhance the chance of detecting a marker 152, in use. Moreover, the user may place different markers within different types of ore parcels to not just track the progression of the ore parcel through the ore traveling path, but also to identify the type of ore parcel that travels past a point along the ore traveling path 154.

The system 150 further includes computer apparatus 168 having a computer database 170 and a computer network interfacing arrangement 172. Similarly, the each detecting arrangement 158 includes a terminal network interfacing arrangement 174 for establishing communication over a wireless data communication network 176 with the computer network interfacing arrangement 172. Thus, information or data can be passed between the detecting arrangements 158 and the computer 168.

The tracking of the ore is broadly done by logging initial relevant parameters of the marker 152 within the ore parcel and then logging relevant detected parameters of the marker as it passes with the ore parcel thought the detection zones of the detecting arrangement 158. The initial parameters and the detected parameters can then be used to obtain and indication of the progress of the ore parcel along the ore traveling path.

Therefore, the system includes an initial logging arrangement, generally indicated by reference numerals 178 and 180 for logging information about an initial instance when the marker is placed within the body of ore blocks and for logging information about an initial position of the body of ore blocks. The initial logging arrangement includes a the transportable detecting apparatus 178 that is in the form of a handheld RFID reader than also has a geographic locating apparatus in the form of a GPS.

Once a marker is place within the ore parcel that is to be tracked, then the use reads the identification information of the marker 152 and also determines the geographic position of the marker with the GPS.

The handheld reader includes a database for storing the identification information of the marker 152, a data stamp, in other words a date and time when the marker 152 is placed within the ore parcel, and information from the GPS of the physical or geographical information of the position of the marker 152.

The hand-held reader includes a data communication interface and can thus be connected in data communication with the computer 168, for example by USB interface, and the initial information of the marker 152 stored on the transportable database can be downloaded with the computer 168 and stored on the computer database 170. An application 180 running on the computer forms thus part of the initial logging arrangement 178 and 180.

The RFID reader 164 interrogates the reader zone continuously and as soon as any one of the markers 152 enters the detecting zone, they announce their unique identification information to the reader. The reader passes this information to its network interfacing arrangement 158 which is in the form of a wireless modem that is in data communication with the computer 168. The detecting arrangement also include a time stamp generating arrangement for stamping the identification information with a time and date. The marker identification information and the time stamp is then transmitted to the computer 168 that can store the detected information on the computer database 170.

The detection logging arrangement performs the function of capturing the detected information and is partly formed by a temporary data store 182 and an application 184 on the computer 184.

The system further includes a presenting arrangement 186 for interpreting and extracting the initial information and the detected information from the computer database 170 and for presenting is information in a format to a user by way of a graphical user interface. Having logged on the database the initial time and position of a marker and the later detected time and position of the marker 152 clearly enables a user to retrieve valuable information from the data, such as the time it took for an ore parcel to reach a certain detection point. Since the geographical positions of the detecting arrangement is known, a user knows when a specific type of ore parcel is within that detecting position along the ore traveling path. This may be valuable information for optimizing the mineral processing process.

The detecting arrangements can be positioned along the ore traveling path at strategic locations, for example next to a conveyor belt, or in front of an ore crusher, or a SAG mill, and the like.

The invention will now be described in more detail with reference to a particular embodiment. In Figs. 1 to 3 a reference numeral 1 refers generally to a marker in accordance with one embodiment of the invention.

The marker 1 comprises broadly a body 3 and a transponder that is a radio frequency identification tag (RFID tag) 5 that is received within the body 3.

The body 3 is in the form of a housing having a flattened substantially cylindrical shape having two major surfaces 7 and 9 that are circular. The cylindrical housing 3 is short and thus the axial length of the wall extending between the two major surfaces 7 and 9 is short.

The housing 3 is made up of two interconnected housing parts 11 and 13. The two housing parts 11 and 13 can be connected to each other to form the closed housing 3 during the assembly of the marker 1 during the manufacturing process.

The housing 3 is made of a hard and strong synthetic material to enable it to have some chance of withstanding blast forces and also to enable it to be passed through a mineral processing plant up to a SAG mill with a reasonable prospect of not being damaged in the plant. Further the housing 3 has a wall thickness of about 3 to 8mm, e.g. about 3-5mm. Again this wall thickness helps the marker 1 to withstand the forces described above.

The housing 3 is largely hollow and defines an interior space shown generally by numeral 15 which is filled with air. The purpose of the air is to absorb much of the force of the blast before it reaches the tag 5 thereby to help the tag to survive the force of the blast.

The housing 3 also includes locating and mounting means shown generally by numeral 16 for locating and mounting the RFID tag 5 securely in position within the housing. The locating and mounting means may comprise mounting formations shown generally by 16 on each of the housing parts 11 and 13.

In the illustrated embodiment there is a mounting formation 16 on each housing part comprising a circumferential locator 21 for locating the RFID tag 5 centrally relative to the side wall of the housing and an axial locator 23 on the major surface of the housing part 11, 13 for locating the major surface of the RFID tag 5 spaced away from the associated major surface 7 or 9 of the housing part 11 or 13.

In the embodiment shown in the drawings the circumferential locator 21 comprises a circular wall 21 within which the RFID tag 5 is circumferentially received, e.g. snugly to mount it centrally within the housing when it is viewed in plan view.

In the illustrated embodiment the axial locator 23 comprises four outwardly projecting rib formations arranged in the form of a cruciform that each extend from the centre of the housing part to the wall 21. The rib formations are equally spaced apart and thus are spaced about ninety degrees apart from each other. The rib formations do not extend up away from the associated major surface of the housing part as high as the wall 21. Thus the wall 21 and rib formations 23 form a secure and stable mounting within which the tag 5 is snugly received. The locators 21 and 23 are designed to hold the tag 5 securely while still providing as much air space between the major surfaces and side wall of the housing part as possible.

Each housing part 11, 13 has a pair of positive clip formations 25 for engaging passive clip formations 27 on the other housing part 11, 13 to attach the housing parts 11, 13 to each other during assembly. In the illustrated embodiment each housing part 11, 13 has two positive clip formations 25 that project out away from the wall of the circumferential locator 21 and are diametrically opposed from each other around the wall.

Further each housing part 11, 13 has two passive clip formations 27 that are basically openings in the wall thereof for receiving a positive clip formation 25 from the other housing part 11, 13 therein.

Further it should be noted that each of the housing parts 11, 13 is basically the same. Thus each housing part has the same circumferential locator 21 and axial locator 23 and the same clip formations 25 and 27. This is clearly not essential but simplifies manufacture of the housing parts 11, 13.

The RFID tag 5 has a flattened circular cylindrical configuration having two major surfaces 29, 31 as shown in the drawings. Its orientation mimics that of the housing parts 11, 13 with its major surfaces 29, 31 extending parallel to the major surfaces of the housing parts 11, 13. Further the tag 5 is received substantially centrally within the housing 3 when viewed in plan view with its circumferential wall spaced radially in from the wall of the housing part 11, 13.

Further the tag 5 is positioned substantially midway along the length of the side wall of the housing 3. That is it is positioned substantially midway along the housing 3 in a depthwise direction of the housing. The purpose of this is to space the tag away from the wall of the housing to reduce the force of a shock wave from a blast as much as possible before it reaches the tag 5.

The RFID tag has a unique identification number to enable and transmits this identification energy in a way that can be picked up by a receiver when it is energized by radio energy. RFID tags are ubiquitous in modern society and are manufactured in large numbers for use in many applications. The RFID Tags are available for off the shelf purchase. As the structure and function of RFID Tags would be well known to persons skilled in the art and will not be described in further detail in this specification.

In manufacture of the marker 1 the two housing parts 11 and 13 are each formed in separate moulding operations, e.g. injection moulding operations. The die which is used to mould the parts is not unduly complex. The housing parts are moulded from a hard and robust plastics material, e.g. BAKELITE™ or glass filled nylon.

Each marker is assembled by placing an RFID tag within a locator on one housing part. The tolerance and position of the locators ensures that the tag is positioned easily and accurately in the correct position within the housing part. The marker is then assembled by snapping the other housing part onto the one housing part containing the RFID tag and the marker is complete. In the illustrated embodiment, no adhesive or the like is required to complete the assembly process. However in other embodiments, solvent welding, ultrasonic welding or adhesives can be used to more completely bond the two housing parts to each other.

Figs. 4 to 8 show generally an apparatus for monitoring the movement of a different ore blocks within an overall ore body. In these drawings the apparatus is indicated generally by the reference numeral 41.

The apparatus 41 comprises a plurality of markers 1 as described above dispersed within the ore body and also a reader shown generally by 43. In broad terms the function of the reader 43 is to read the identity of the RFID tag 5 of each marker 1 that comes into its range. The reader also reads the location and/or time stamp when it reads an RFID tag 5.

Fig. 4 is a schematic drawing showing the functionality of the RFID tag 5 within the marker 1.

The RFID tag 5 has a unique identification number 45 which is a combination of 1's and 0's or binary code as shown in the drawing.

The RFID tag 5 is energised by radio energy from the tag reader 43 and specifically an antenna 47 of the tag reader 43 when it comes into the range of the antenna, typically within 5 m of the antenna. In

response to being energised in this way the tag 5 sends out a return radio signal giving its unique identification number 45.

In use the antenna 47 of the reader 43 sends out RF energy and when a marker 1 comes within range of the antenna the RF energy issuing from the antenna 47 energises the RFID tag 5 and causes it to send back its unique identification 45 by means of a return radio wave.

Fig. 5 is a schematic drawing showing the different components making up the apparatus 41 and how they interact with each other.

In Fig. 5 two types of readers are shown namely a stationary reader 43 that is placed in a fixed position along the path of the plant and also a hand held reader 57 that is carried around by an operator.

In addition to the components described above with reference to Fig. 4 the apparatus 41 also includes a data collection means 49, typically in the form of a computer having a database, that records the identity and time of each of the RFID tags 5 recorded by each of the readers 43. This then serves as the basis for tracking the progress of different ore blocks within an ore body and when the various ore blocks are undergoing the different unit operations such as crushing and milling.

A plurality of markers 1 is placed in a particulate ore body at different positions in the ore body. These positions in the ore body broadly demarcate ore body portions or blocks and thereby when the markers 1 are read by the readers in the plant it broadly indicates where the associated ore block is within the plant and when it will be processed by the different unit operations.

In Figs. 5 and 6 a conveyor belt is indicated broadly by reference numeral 51 within a particulate material 53 to be processed.

A stationary reader 43 is positioned above a conveyor belt 51. The reader 43 comprises a flattened body having two major surfaces 54 and 55 of broadly rectangular configuration.

The reader 43 is orientated with its major surfaces 54, 55 extending horizontally at a position spaced about 1-1.5m above the conveyor belt 51. The long axis of the reader 43 extends in the direction of width of the conveyor belt 51 and extends across at least half of the width of the conveyor belt 51.

The orientation of the reader 43 is arranged in this way to increase the flux of radio energy directed down onto the conveyor belt 51. Further it increases the chance of locating markers 1 on the conveyor belt 51 irrespective of their position across the width of the conveyor belt 51.

The reader 43 is operatively coupled to a power supply for energising the antenna. This may be a mains power supply. The power supply may also be a solar panel for a remote installation as shown in the drawings.

The apparatus also includes hand held readers 57 that are used to log the initial positions of each of the markers 1 when they are first placed in positions within the ore material.

In one form the markers 1 are placed in the rock material before it has been blasted. In another form the markers 1 are placed in the particulate material on the surface of the muck pile to mark different ore blocks or ore portions within the ore body.

Fig. 7 is a schematic three dimensional view of a hand held reader 57.

The reader 57 comprises a housing, an antenna, and a power supply such as a battery power supply contained within the housing. It also contains a GPS position locator for logging the initial positions of markers and a clock for enabling a user to give each marker that is logged a time stamp. The reader is hand held and is light enough to easily be carried around much like a mobile telephone.

The hand held reader 57 may include a screen 59 that displays information such as the identification of the marker 1 and its location as determined by the GPS position locator.

The data collection means 49 includes a database for collecting and organising data on the various tags 5 and the time when they are read by the readers 43 and 57. The data processing means may comprise a computer, e.g. a PC, with an interface comprising a screen and a keyboard. Fig. 8 illustrates an example display on the screen of the computer forming the data collection means.

Further the apparatus 41 may include means for facilitating communication between the various readers, both hand held readers and stationary fixed position readers. The communication facilitating means may include cables hardwiring the components to each other. It may also include a wireless communication link.

In use the hand held readers are used to log the location of each of the markers in the initial rock body, be it still intact or blasted. This information is used together with information on the ore body being blasted to determine where the different ore blocks are located within the body prior to sending the particulate material into the processing plant.

As shown in Figs. 5 and 6 once the material is in the plant markers 1 are conveyed along the belt 51 within the material 53. Radio energy that is transmitted by the reader 43 causes the markers 1 located in the particulate ore 53 on the conveyor belt 51 to be energized. This in turn causes the tag 5 within the marker 1 to send a signal back identifying the unique RFID tag 5 of that particular marker 1 which is received by the reader 43. The reader 43 then sends this information through to the data collection means which systematically logs this information in its database.

Figs. 9 and 10 illustrate one example application of the apparatus in a mining environment. In this application the purpose of the apparatus is to measure the movement of ore block boundaries or ore block interfaces particularly in complex ore bodies as a result of the blasting of the host rock to break it up.

In this application a plurality of markers 1 are placed in blast stemming holes 61 that are filled with explosive prior to a blast. The markers 1 are positioned spaced apart from each other across the area of the ore body to be blasted (when viewed in plan view) so that the results can give a good idea of rock movement.

Fig. 9 illustrates an operator placing a marker 1 in an explosive hole 61. Generally the marker 1 will be placed in the hole 61 such that it is received well within the hole 61, e.g. reasonable deep within the hole so that it is not shot out of the hole by the force of the blast. (It would not work to simply place the markers 1 on the surface of the rock body prior to the blast).

The markers do not need to be placed in each explosives hole. Generally the markers will be arranged spaced apart from each other broadly in the form of an array when the area being blasted is viewed in plan view. Further while it is not necessary for the markers to be placed in the same holes at the explosives Applicant has found that this is advantageous because the holes are labour intensive and therefore expensive to drill. Further Applicant has established that its markers have a good survival rate, e.g. about 80%, when placed in the same holes as the explosives.

After the explosives and markers have been packed into the blast holes or stemming holes the holes are closed up with tamping material. The location of the marker is then logged by means of a hand held reader 57 as shown in Fig. 7.

The explosives are then detonated to break up the rock body into pieces. The time that the markers pass through the crusher is then used together with the mine dispatch system to back calculate where

the tag was extracted from. This is used to calculate the lateral movement or dislocation of the surrounding region of the ore block as a result of the blast.

This enables the three dimensional geological map of the different ore blocks in the ore body to be adjusted to take into account the movement occurring as a result of blasting.

That is the movement can be used to directly determine where the boundaries of the different ore blocks are located after the blast. This information in turn can be used in the subsequent processing of the ore to reduce ore dilution. That is the amount of ore being sent to the tailings dump is reduced as is the amount of waste being sent to the concentrator. This has been identified as a major cause of reduce efficiency and loss of values in mining operations and associated mineral processing operations.

Fig. 10 is a surface map of one example application of the invention. The drawing shows the initial location of the various markers 1 prior to the blast as well as the positions of the markers 1 after the blast. This example shows clearly the movement of the rock body and hence the boundaries between the different ore blocks or ore body portions within the overall ore body. This movement is considerable and should therefore be taken into account by mine operators. It should not be assumed to be zero as occurs in many prior art mining practices of which the Applicant is aware.

Applicant has found that using this method can significantly reduce the ore dilution in a plant caused by discrepancies between the assumed ore body boundaries in a complex ore body and the actual ore block boundaries in such an ore.

Figs. 11 and 12 illustrate an apparatus for tracking the progress of different ore blocks of an ore body through a mineral processing plant from the blast through to the SAG mill. This apparatus constitutes a different embodiment of the invention to that described above with reference to Figs. 9 and 10.

In Figs. 11 and 12 the apparatus is indicated generally by numeral 71 and a mineral processing plant is shown generally by numeral 73 for processing particulate material.

The plant 73 comprises broadly a muckpile of broken rock 75 formed at the blast site and a crusher 77 for crushing the broken rock. It also includes a first conveyor 79 for conveying the broken rock to an intermediate heap 81 and then a second conveyor 83 for conveying the particulate material from the intermediate heap 81 to the mill 85, e.g. a SAG mill.

The plant 73 also includes a set of loaders, e.g. front end loaders 76 for transferring the broken rock from the muckpile 75 to the crusher 77. The loader 76 tips each load of particulate ore material into an open top of the crusher 77.

The intermediate heap 81 also includes means for metering the flow of particulate material from the heap 81 onto the second conveyor belt 83.

The apparatus 71 comprises broadly markers 1 located within the particulate material shown by numeral 1 at various stages of progress through the plant 73. The markers 1 are the same as those described above and illustrated in Figs. 1 to 3. The marker is sized to have a long dimension that is less than the distance between the operative crusher surfaces. This helps to achieve a good survival rate of markers passing through the crusher while they are still in a fu8nctionbal and operative state.

The apparatus 1 also includes a hand held reader 87 that is used by an operator walking on top of the muck pile 75. The handheld reader 87 logs the position of each of the markers 1 after the blast and before the material is loaded into the crusher 77.

The apparatus 71 also includes a first stationary reader 89 that is positioned above the first conveyor belt 79 adjacent to the crusher 77. The apparatus 71 also includes a second stationary reader 91 that is mounted above the second conveyor 83 downstream of the intermediate heap 81.

Yet further the apparatus 71 also includes a data collection means 95 for collecting and organising and presenting information on the markers 1 based on the readings taken by the readers 5. The data collection means may comprise a computer with a screen capture like that described above with reference to Fig. 8. Further in the embodiment shown in the drawings the stationary readers 89 and 91 and the hand held reader 87 communicate wirelessly with the data collection means.

Fig. 12 is a schematic longitudinal sectional view through a conveyor belt 79, 83 and the particulate material being carried on the belt 79, 83. This drawing shows schematically how the markers 1 can be used to mark or delineate different ore blocks, shown respectively by numerals 101, 103 and 105, traveling along the belt.

In use the markers 1 are positioned in the rock body (either intact or broken) so as to indicate broadly the boundaries of different ore blocks 101, 103 and 105 within a complex ore body when used in combination with a three dimensional geological map of the ore body showing the ore boundaries in the rock body. The positions of these markers 1 both pre-blast and post-blast are then logged on the data collection means using the hand held reader 87.

Thereafter the particulate material is progressively loaded in small batches into the crusher 77 by means of the loaders 76. The first and second stationary readers 87, 89 log the time when the various markers 1 pass beneath them on the conveyor belts 79, 83.

This then provides a guide to when the different ore blocks are being processed within the crusher 77 and the mill 85. This information in turn can be used to improve simulation of the plant. The simulation in turn can be used to optimise operation of the plant.

The markers are generally broken up when they are passed through the SAG mill. The markers and their component parts are not recovered and as a whole are consumed in use. Further by virtue of their destruction in the SAG mill the markers cannot track the movement of the ore blocks through the plant downstream of the mill.

Thus in this embodiment the apparatus 71 is used to track the movement of ore blocks 101, 103, and 105 from a muck pile 75 at a blast site through the crusher 77 along a conveyor belt system 79, 83 and then into a comminution apparatus such as a SAG mill 85.

An advantage of the marker described above is that it is robust and has a good chance of surviving in a functional form in its travel through the plant from the muck pile to the SAG mill. This is important for it to be able to be read by the readers at various positions in its progress through the plant. In particular the marker is sized so that is can pass between the jaws of a typical crusher so that most markers survive passage through the crusher. This is important for the invention to provide a cost effective way of tracking passage of an ore through a plant.

A further advantage is that the shape of the marker described and illustrated above is that it has tendency to orientate itself with one of its major surfaces in a broadly horizontally extending orientation when it is mixed up with a particulate ore. It will generally settle with a major surface facing upwardly. This feature together with the RFID in a similar orientation within the housing has the effect that the RFID tag has its greatest surface facing upwardly to receive radio energy from a reader positioned above the conveyor belt. This increases the likelihood that the tag will be read by the reader when it passes beneath it on the conveyor belt.

A yet further advantage of the marker described above is that its construction enables it to have a good chance of surviving a blast if it is placed in a blast stemming hole prior to blasting. The feature of

having the RFID tag largely surrounded by an air space within the housing helps to dampen the shockwaves caused by blasting. This assists the RFID to survive the blast.

A further advantage of the marker described above is that RFID tags are widely used in a number of diverse applications and are extremely reliable in operation. Their operation and manufacture has been fine tuned and they are available off the shelf at reasonable cost and perhaps even low cost. They are manufactured by a number of manufacturers around the world in extremely large quantities. These factors contribute to this invention being such a cost effective solution to the problems addressed in this application. This is important as the markers are ultimately consumed in use when they are passed through the SAG mill.

A yet further advantage of this invention is that the markers are reasonably simple in construction and can be made fairly inexpensively. As described immediately above the tags are easily obtained. Further the housing can be made by moulding the two housing parts in a simple moulding operation such as an injection moulding operation. Further the locating and mounting formations can be moulded integrally with the associated housing part and thus do not need to be assembled onto the housing part after it has been moulded.

The markers are assembled in a simple assembly process by placing an RFID tag within a locating formation of a housing part and then snapping another housing part into position on top of the tag and housing part. A yet further advantage is that the marker has no moving parts.

A yet further advantage of the apparatus described above is that the RFID readers also use well known technology and can be easily made or even possibly bought off the shelf. The antennas would be manufactured widely and use well established and well understood technology. This in turn helps the apparatus of this invention to operate in a reliable fashion.

A yet further advantage of the apparatus described above is that the data collection means comprises a PC computer and database of the type which is freely available. Yet further the readers can communicate with the data collection means by well known and well established hardwire means of communication and hardwire means of communication.

A yet further advantage of the apparatus described above is that it has a hand held reader that can log an identity of an RFID tag and a position by means of GPS. It also has a fixed position reader that logs RFID identity and the time stamp when it passed though that section of the plant. These two features

give the apparatus a unique ability to deal with material in piles or heaps and also material traveling along conveyor belts.

A further advantage of the method an apparatus described above is that it is able to track different blocks of ore through a plant even though the plant may have an intermediate heap onto which the particulate material is discharged after the crusher and before it is transported to the mill. Yet further the apparatus is able to track ore block through a plant even when different ores are blended together.

It will of course be realised that the above has been given only by way of illustrative example of the invention and that all such modifications and variations thereto, as would be apparent to persons skilled in the art, are deemed to fall within the broad scope and ambit of the invention as is herein set forth.

CLAIMS:

1. A system for tracking progression of a body of ore blocks that travels along an ore traveling path through a process, which system includes:

at least one marker having an onboard storage arrangement for storing unique identification information for the marker, each marker being for placement within the body of ore blocks that is to travel along the ore traveling path through the process;

an initial logging arrangement for logging information about an initial instance when the marker is placed with the body of ore blocks and for logging information about an initial position of the body of ore blocks;

at least one detecting arrangement placed along the ore traveling path at an detection zone defining a detection position, each detecting arrangement being for detecting the at least one marker when it travels within the body of ore through the detection zone;

a detection logging arrangement for logging information about a detected instance when the at least one marker is detected by the detecting arrangement and for logging information about a detected position at which the marker is detected by the detecting arrangement; and

a presenting arrangement for extracting and presenting the logged information about the initial instance and the detected instance of the marker, and for presenting the logged information about the initial position and the detected position of the marker, thereby to track the progression of the body of ore blocks that travels along the ore traveling path through the process.

2. A system as claimed in claim 1, in which the marker includes a capsule having an interior, the capsule including a robust outer wall for shielding the onboard storage arrangement from the body of ore blocks with which it travels along the ore travel path.

3. A system as claimed in claim 1 or claim 2, in which the detecting arrangement includes an interrogating arrangement for continuously interrogating the detection zone for detecting the at least one marker when it travels with the body of ore blocks through the detection zone.

4. A system as claimed in any one of the preceding claims, in which the marker includes an announcing arrangement for announcing the presence of the marker within the detection zone when interrogated by the detecting arrangement as the marker travels with the body of ore through the detection zone.

5. A system as claimed in claim 4, in which the announcing arrangement includes a transponder that is responsive to the interrogating arrangement, the transponder being in communication with the

information storage arrangement for transmitting the unique identification information of the marker to the detecting arrangement in response to interrogation from the interrogating arrangement.

6. A system as claimed in claim 5, in which the transponder and storage arrangement is a radio frequency identification (RFID) tag.

7. A system as claimed in claim 5 or claim 6, in which the interrogating arrangement includes a RFID reader device.

8. A system as claimed in any one of claims 3 to 7, in which the at least one marker includes a plurality of markers, each marker having an onboard storage arrangement for storing its unique identification information, the plurality of markers being for placement within the body of ore blocks that is to travel along the ore traveling path though the mining process.

9. A system as claimed in claim 8, in which some of the plurality of markers are placed within one type of body of ore blocks and others of the plurality of markers are placed within another type of body of ore blocks.

10. A system as claimed in any one of the preceding claims, which includes a computer apparatus having a computer database and a computer network interfacing arrangement.

11. A system as claimed in any one of the preceding claims, in which each detecting arrangement includes a terminal network interfacing arrangement for establishing communication over a wireless data communication network with the computer network interfacing arrangement.

12. A system as claimed in any one of the preceding claims, in which the initial logging arrangement includes a transportable detecting apparatus that is transportable to a relevant marker for interrogating the relevant marker so that the relevant marker announces its unique identification information to the transportable detecting apparatus, and a geographic location determining apparatus for determining the position of the relative marker along the ore traveling path.

13. A system as claimed in claim 12, in which the transportable detecting apparatus includes a transportable database for storing the identification information of the relevant marker and the geographic location of the relevant marker.

14. A system as claimed in claim 12 or claim 13, in which the transportable detecting apparatus includes a time stamping arrangement for generating time and date information at the instant at which the transportable detecting apparatus receives the identification information from the relevant marker.

15. A system as claimed in claim 13 or claim 14, in which the transportable detecting apparatus populates the transportable database with the associated identification information of the relevant marker, information about its determined position, and information about the generated time and date.

16. A system as claimed in any one of claims 13 to 15, in which the transportable detecting apparatus and the computer apparatus includes a data communication interfacing arrangement for downloading the initial information from the transportable detecting apparatus to the computer apparatus, so that the computer apparatus populates the computer database with the downloaded initial information.

17. A system as claimed in any one of the preceding claims, in which each detecting arrangement is a stationary detecting arrangement and includes a terminal network interfacing arrangement for connection in communication over a wireless data communication network with the computer network interfacing arrangement.

18. A system as claimed in any one of the preceding claims, in which the detection logging arrangement includes a stationary database at each stationary detecting arrangement, each stationary database being for storing the identification information of a maker that is detected when traveling with the body of ore through its associated detection zone.

19. A system as claimed in claim 10, in which the computer data communication interfacing arrangement is for downloading the identification information from each stationary database to the computer apparatus, and for downloading a unique identification point address of the stationary detecting arrangement, so that the computer apparatus populates the computer database with the downloaded unique identification information of the marker that passed through the detecting zone and with the associated unique detecting arrangement address.

20. A system as claimed in claim 10, in which the stationary detecting arrangement includes a time stamping arrangement for generating time and date information at the instant at which the stationary detecting arrangement receives the identification information from the marker passing through its associated detection zone.

21. A system as claimed in claim 10, in which the computer apparatus populates the computer database with information of the address of each stationary detecting arrangement, the identification information of the detected markers passing thought detection zone of each stationary detecting arrangement, and the generated time stamp for each marker.

22. A system as claimed in claim 10, in which the computer apparatus includes the presenting arrangement for comparing the initial time stamp of each marker with its detected time stamps, and for comparing the initial position of each marker with its detected position, and for populating the computer database for each marker with its compared information, thereby to determine the detecting points that the markers, and hence the body of ore blocks, have passed and the time that has elapsed until the markers passed the detecting points.

23. A system as claimed in claim 10, in which the computer apparatus includes a user interface for presenting the populated information in the computer database to the user.

24. A system as claimed in claim 10, in which the computer apparatus includes a setup arrangement for setting the stationary detecting arrangements and the associated locations and address identification information of each stationary detecting arrangement on the computer database.

25. A method for tracking progression of a body of ore blocks that travels along an ore traveling path through a process, which method includes:

placing at least one marker within the body of ore blocks that is to travel along the ore traveling path though the mining process, each marker having a unique identification information stored in an onboard storage arrangement of the marker;

logging an initial instance and an initial position of the body of ore blocks with an initial logging arrangement;

placing at least one detecting arrangement along the ore traveling path at a detection zone defining a detection position, and detecting the at least one marker when it travels with the body of ore through the detection zone; and

logging the detection instance and the detection position when the at least one marker is detected by the detecting arrangement; and

comparing the initial and the detection instances with each other, and comparing the initial position and the detection position with each other with a presenting arrangement, thereby to track the

progression of the body of ore blocks that travels along the ore traveling path through the mining process.

26. A method as claimed in claim 25, in which placing at least one marker includes placing a capsule within the body of ore blocks, the capsule having an interior and an outer robust wall for shielding the onboard storage arrangement from the body of ore blocks with which it travels along the ore traveling path.

27. A method as claimed in claim 25 or claim 26, which includes continuously interrogating the detection zone with the detecting arrangement having an interrogating arrangement for detecting the at least one marker when it travels with the body of ore blocks through the detection zone.

28. A method as claimed in any one of claims 25 to 27, which includes providing the marker with an announcing arrangement for announcing the presence of the marker within the detection zone when interrogated by the detecting arrangement as the marker travels with the body of ore through the detection zone.

29. A method as claimed in any one of claims 25 to 28, in which the announcing arrangement includes a transponder responsive to the interrogating arrangement, the transponder being in communication with the information storage arrangement, the method including transmitting the unique identification information to the detecting arrangement in response to interrogation from the interrogating arrangement.

30. A method as claimed in any one of claims 27 to 29, which includes providing the transponder and the storage arrangement onboard the marker by mounting a radio frequency identification (RFID) tag inside the marker.

31. A method as claimed in any one of claims 27 to 30, which includes providing the interrogating arrangement with a RFID reader device.

32. A method as claimed in any one of claims 25 to 31, in which the at least one marker includes a plurality of markers, each marker having an onboard storage arrangement for storing unique identification information, the method including placing a plurality of markers within the body of ore blocks that is to travel along the ore traveling path though the mining process.

33. A method as claimed in claim 32, which includes placing some of the plurality of markers within one type of body of ore blocks and placing some other markers within another type of body of ore blocks.

34. A method as claimed in any one of claims 25 to 33, which includes providing a computer apparatus having an information database and a computer network interfacing arrangement.

35. A method as claimed in any one of claims 25 to 34, which includes providing each detecting arrangement with a terminal network interfacing arrangement and establishing a connection between the detecting arrangement and the computer network interfacing arrangement over a wireless data communication network.

36. A method as claimed in any one of claims 25 to 35, which includes providing the initial logging arrangement with a transportable detecting apparatus that is transportable to a relevant marker and interrogating the relevant marker so that the relevant marker announces its unique identification information to the transportable detecting apparatus, and providing the initial logging arrangement with a geographic location determining apparatus and determining the initial position of the relevant marker along the ore traveling path.

37. A method as claimed in claim 36, which includes providing the transportable detecting apparatus with a transportable database and storing the identification information of the relevant marker and the geographic location of the relevant marker in the transportable database.

38. A method as claimed in claim 36 or claim 37, which includes providing the transportable detecting apparatus with a time stamping arrangement and generating time and date information at the instant at which the transportable detecting apparatus receives the identification information from the relevant marker.

39. A method as claimed in any one claims 34 to 38, which includes populating the transportable database with the associated identification information of the relevant marker, its determined position, and the generated time stamp.

40. A method as claimed in any one of claims 34 to 39, which includes providing the transportable reader and the computer apparatus with a data communication interfacing arrangement and

downloading the information form the transportable reader to the computer apparatus, and populating the computer database with the downloaded initial information.

41. A method as claimed in any one of claims 35 to 40, which includes providing each detecting arrangement with a terminal network interfacing arrangement and establishing a connection between the computer network interfacing arrangement and each one of the terminal network interfacing arrangements over a wireless data communication network.

42. A method as claimed in any one of claims 35 to 41, which includes providing each detecting logging arrangement with a stationary database and storing in each stationary database the identification information of a maker that is detected when traveling with the body of ore through the detection zone of the detecting arrangement.

43. A method as claimed in any one of claims 35 to 41, which includes downloading the identification information of each marker from each stationary database to the computer, and downloading a unique identification point address of the detecting arrangement, and populating the computer database with the downloaded unique identification information of each marker passing through the detecting zone and with the associated unique detecting arrangement address.

44. A method as claimed in any one of claims 34 to 43, which includes providing the detecting arrangement with a time stamping arrangement for generating time and date information at the instant at which the detecting arrangement receives the identification information from the marker passing through the detection zone.

45. A method as claimed in any one of claims 34 to 44, which includes populating the computer database with the associated identification information of each one of the detected markers, and information about the position of the detecting arrangement, and the generated time stamp.

46. A method as claimed in any one of claims 25 to 46, which includes providing the presenting arrangement with the computer apparatus and comparing for each marker its initial time stamp with its detected time stamp, and comparing for each marker its initial position with its detecting positions, and populating the computer database for each marker with the unique addresses of the detecting points that it has passed and the time taken for the marker to pass between the detecting points.

47. A method as claimed in any one of claims 34 to 46, which includes providing the computer apparatus with a user interface and presenting the information in the computer database to the user.

48. A method as claimed in any one of claims 34 to 47, which includes providing the computer apparatus with a setup arrangement and setting the detecting arrangements and for storing the associated location and address identification information in the computer database.

49. An ore block marker for use with a system for monitoring progression of a body of ore blocks transported through a mining process, the ore block marker including:

a marker body; and

a transponder mounted or mountable within the marker body,

the marker body and the transponder when mounted within the marker body being for placement within the body of ore blocks and being detectable by the system as it passes thought the mining process along with the body of ore blocks, thereby to monitor progression of the body of ore blocks through the mining process.

50. A marker as claimed in claim 49, in which the marker body includes a robust outer sidewall defining an interior cavity within which the transponder is mounted.

51. A marker as claimed in claim 49 or claim 50, in which the outer sidewall defines opposed major end walls and a minor sidewall extending between the end walls, the outer wall having a shape and size that will encourage it to come to rest on its major end walls.

52. A marker as claimed in any one of claims 49 to 51, in which the outer sidewall is shaped and sized to form a close-ended shallow circular cylindrical body having two opposed generally circular end walls and a shallow cylindrical sidewall extending between the end walls and merging with the end walls to form rounded circumferential edges at the transition.

53. A marker as claimed in any one of claims 49 to 52, in which the marker body is shaped and sized so that when it is placed within a body of ore blocks it moves with the body of ore blocks without significant segregation due to size.

54. A marker as claimed in any one of claims 49 to 53, in which the marker has a specific gravity correspond broadly to a gross mean specific gravity of the body of ore blocks within which it is to be pleased, in use.

55. A marker as claimed in claim 54, in which the marker has a specific gravity of between 1.5 and 3.0.

56. A marker as claimed in any one claims 49 to 55, in which the marker body includes at least one mounting formation in the interior of the marker body, the mounting formation being for mounting the transponder inside the interior of the marker body.

57. A marker as claimed in any one of claims 49 to 56, in which the marker body include an inner wall inside the interior of the marker body, the inner wall being spaced from the outer wall so that a gap is defined between the inner wall and outer wall.

58. A marker as claimed in claim 57, in which the inner wall is a circular cylindrical inner wall extended concentrically between the two end walls, the inner wall defining a cavity in which the transponder is mountable.

59. A marker as claimed in any one of claims 49 to 58, in which the transponder includes a storage for storing identification information unique to the transponder, and being capable of transmitting the identification information to a receiver device forming part of the system.

60. A marker as claimed in claim 59, in which the transponder is a radio frequency identification (RFID) tag.

61. A marker a claimed in claim 59 or claim 60, in which the RFID tag is embedded in a body protecting material, and in which the body of protective material is shaped and sized to fit snugly inside the cavity defined by the inner wall.

62. A marker as claimed in claim 61, in which the RFID tag is mounted within the body with an orientation so that its area of greatest flux is exposed for the reader when the marker body orientates itself onto its major surface.

63. A marker as claimed in claim 62, in which the marker body includes two body parts that are attachable to each other to form the marker body once the tag mounted on one of the body parts.

64. A marker as claimed in claim 63, in which the body parts are attached to each other by means of complementary clip formations.

65. A marker as claimed in claim 64, in which each body part includes a said mounting formation and the RFID tag is clamped tightly between the two mounting formations when the housing parts are attached to each other.

66. A marker as claimed in claim 65, in which the outer wall has a thickness of between 3 and 8 mm.

67. A method of manufacturing an ore block marker for use with a system for monitoring progression of a body of ore blocks transported through a mining process, the method including:

forming a marker body having an interior; and

mounting a transponder within the interior of the marker body,

the marker body and the transponder when mounted within the marker body being for placement with the body of ore blocks and being detectable by the system as it passes thought the mining process along with the body of ore blocks.

68. A method as claimed in claim 67, in which forming the marker body includes forming a robust outer sidewall for the marker body defining an interior cavity within which the transponder is mounted.

69. A method as claimed in claim 67 or claim 68, which includes shaping and sizing the outer sidewall so that it defines opposed major end walls and a minor sidewall extending between the end walls to encourage the marker to rest on its major end walls.

70. A method as claimed in any one of claims 67 to 69, which includes shaping and sizing the outer sidewall so that it forms a close-ended shallow circular cylindrical body having two opposed generally circular end walls and a shallow cylindrical sidewall extending between the end walls and merging with the end walls to form rounded circumferential edges at the transition.

71. A method as claimed in any one claims 67 to 70, which includes forming at least one mounting formation in the interior of the marker body, the mounting formation being for mounting the transponder inside the interior of the marker body.

72. A method as claimed in any one of claims 67 to 71, which includes providing a transponder in the form of a radio frequency identification (RFID) tag having a storage for storing identification information unique to the transponder, and being capable of transmitting the identification information to a receiver device forming part of the system.

73. A method as claimed in claim 72, which includes embedding the RFID tag within a body of protective material, and shaping the body of protective material snugly to fit inside the cavity defined by the inner wall.

74. A method as claimed in claim 73, which includes mounting the RFID tag within the body so that its area of greatest flux is exposed for the reader when the marker body orientates itself onto its major surface.

75. A method as claimed in claim 74, which includes forming mounting formations inside an interior of each body part, and mounting the RFID tag in position by clamping it tightly between the two mounting formations when the housing parts are attached to each other.

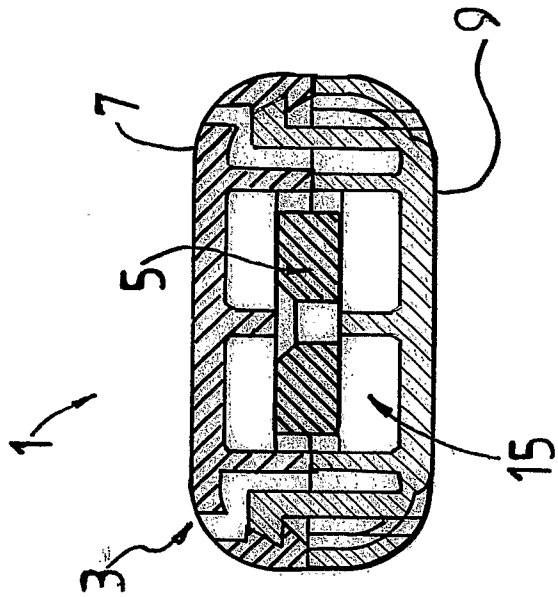


FIG 3

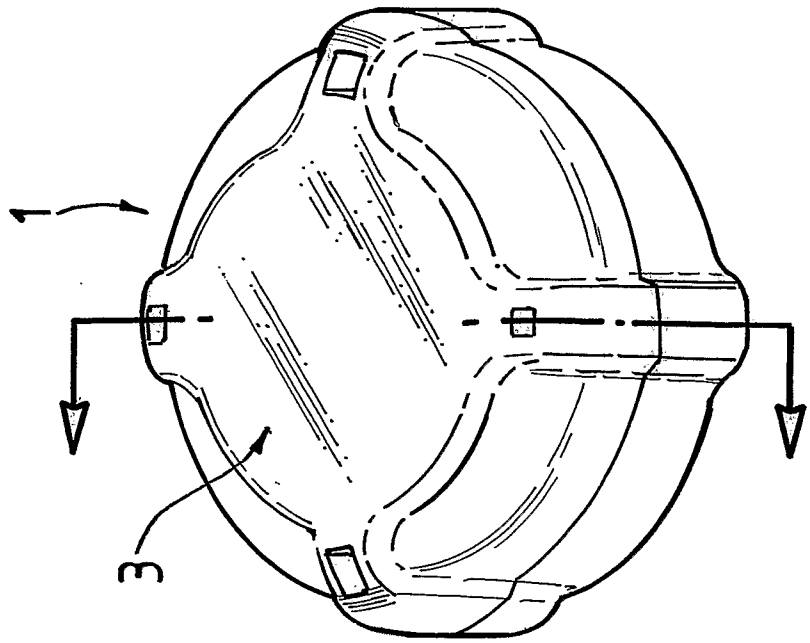
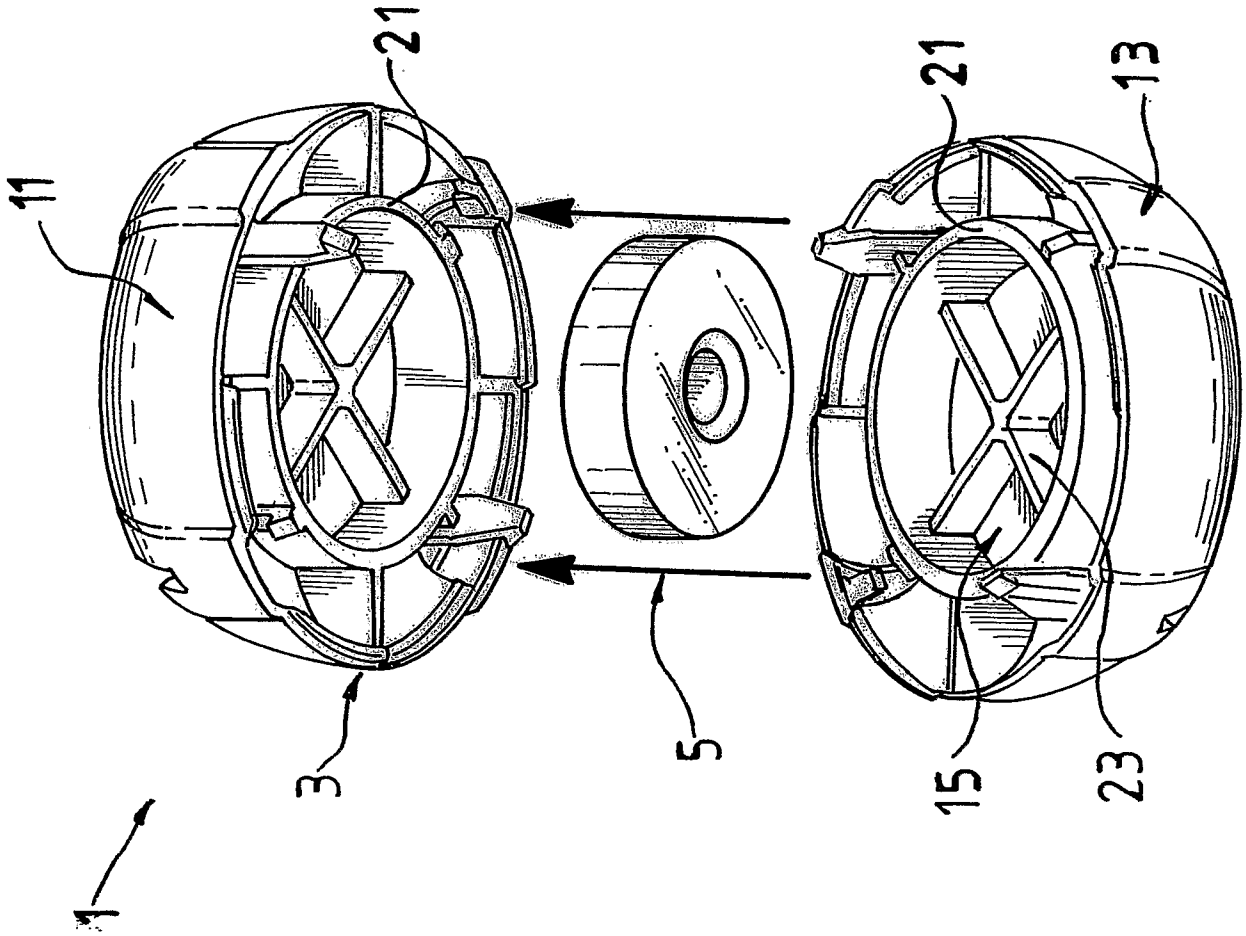


FIG 1

FIG 2



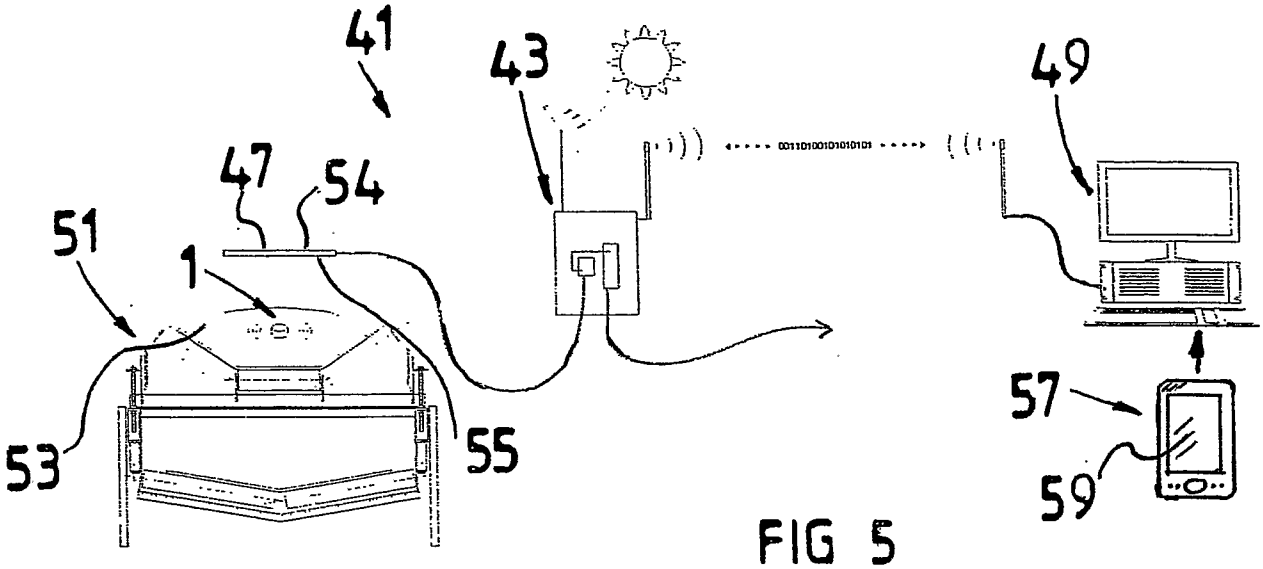


FIG 5

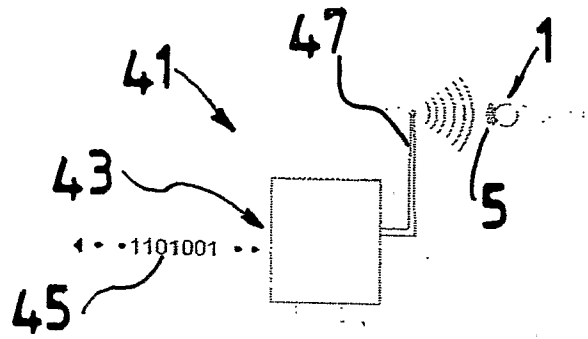


FIG 4

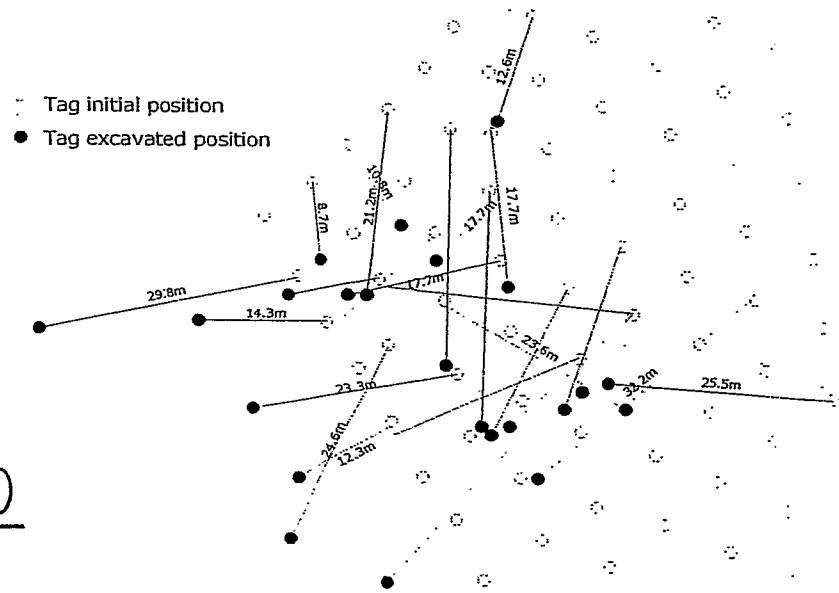
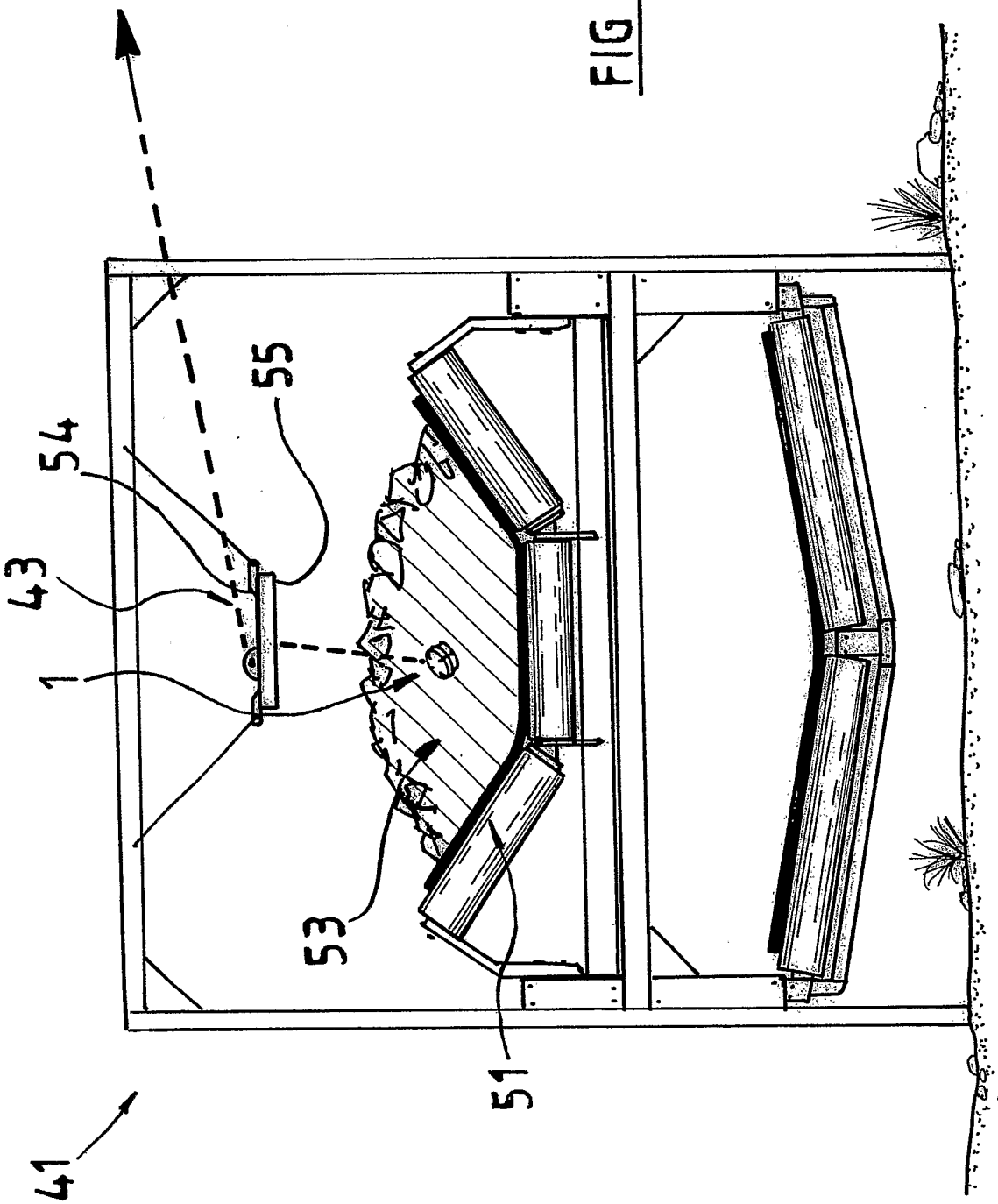


FIG 10

FIG 6



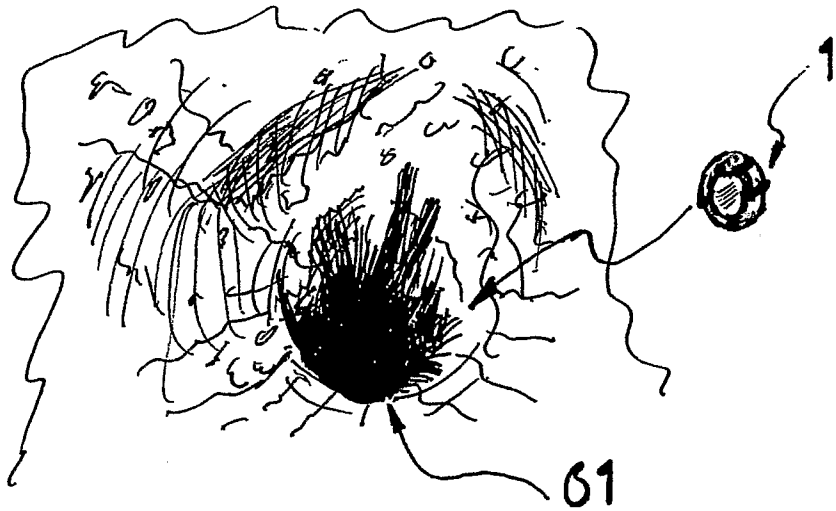


FIG 9

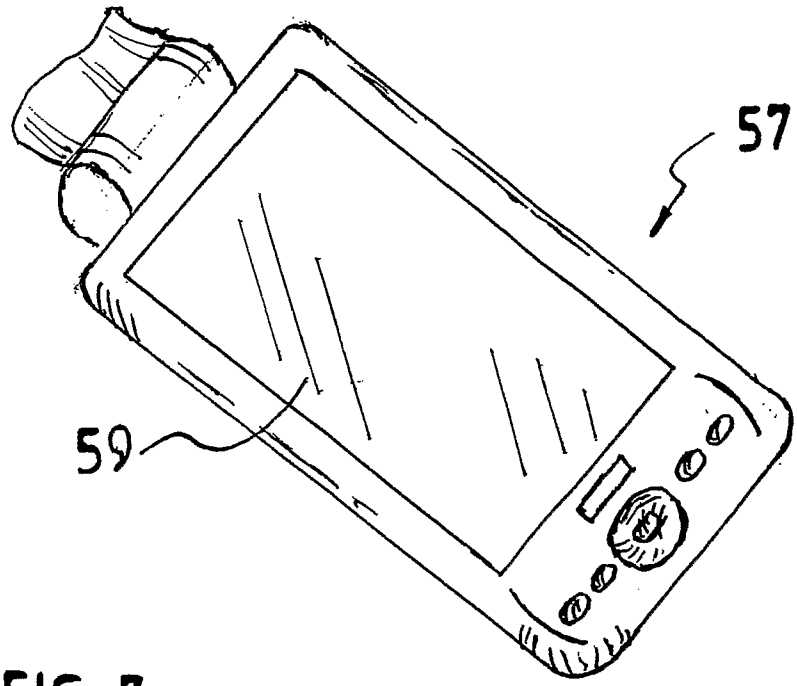


FIG 7

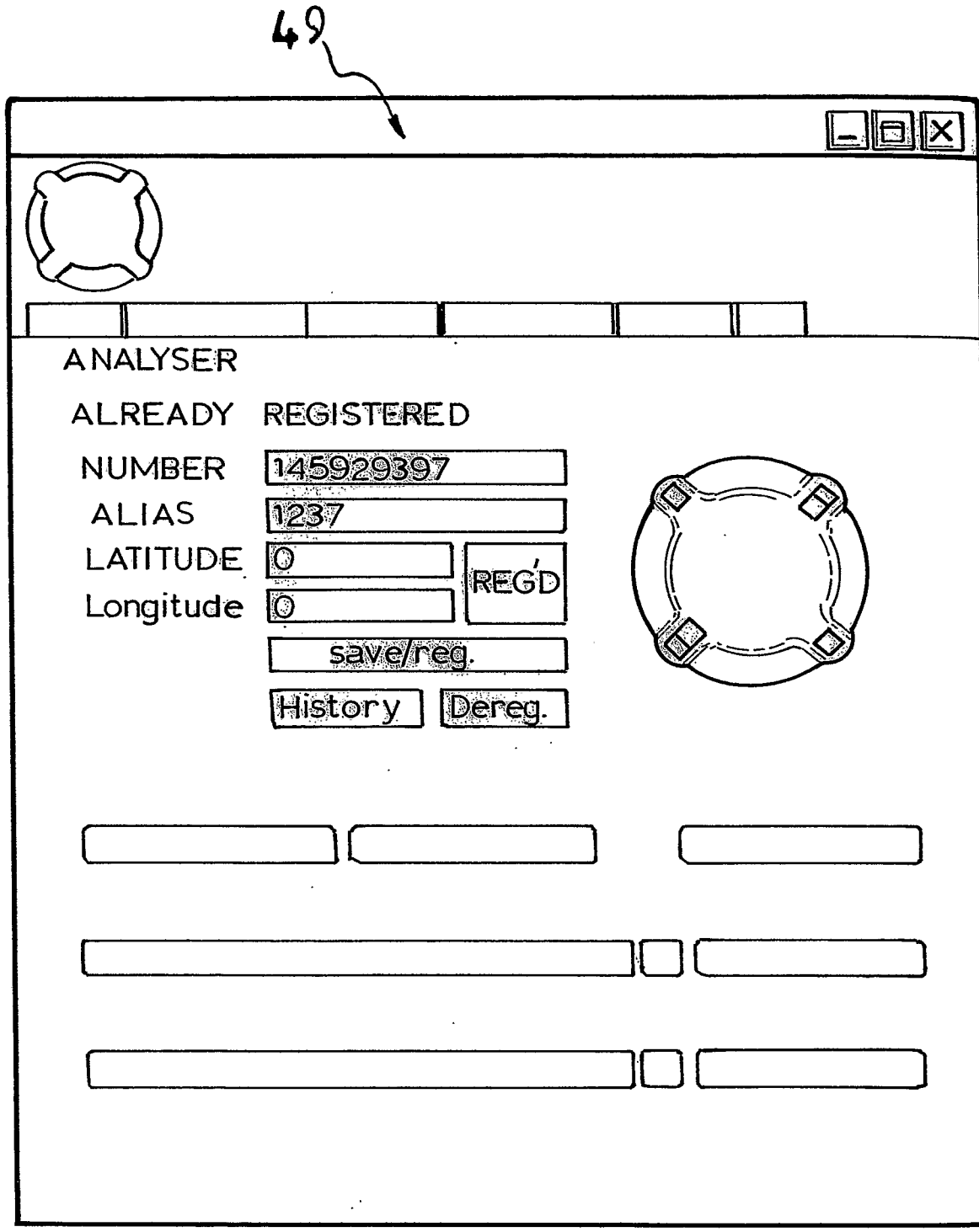

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FIG 8

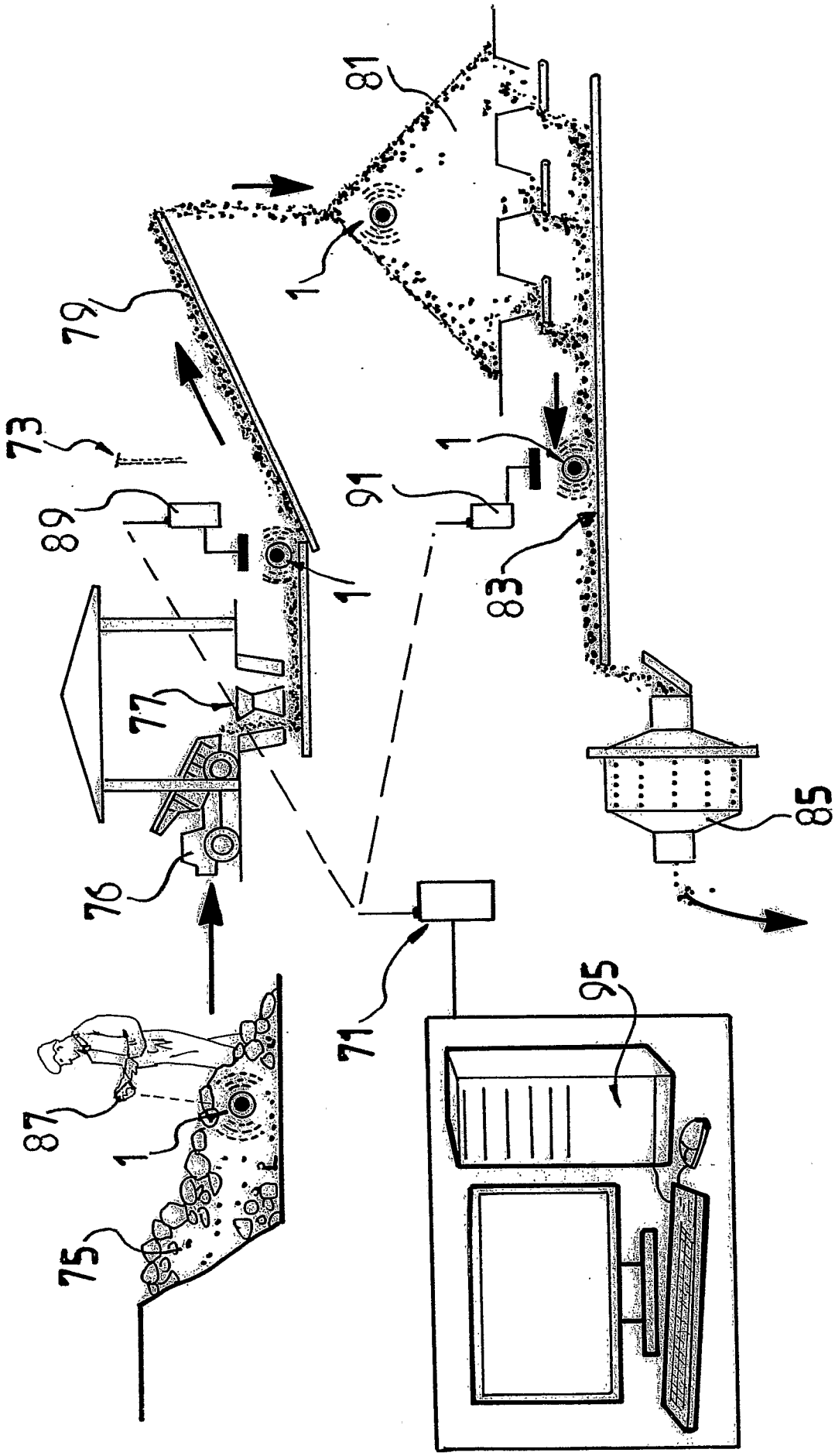

FIG 11

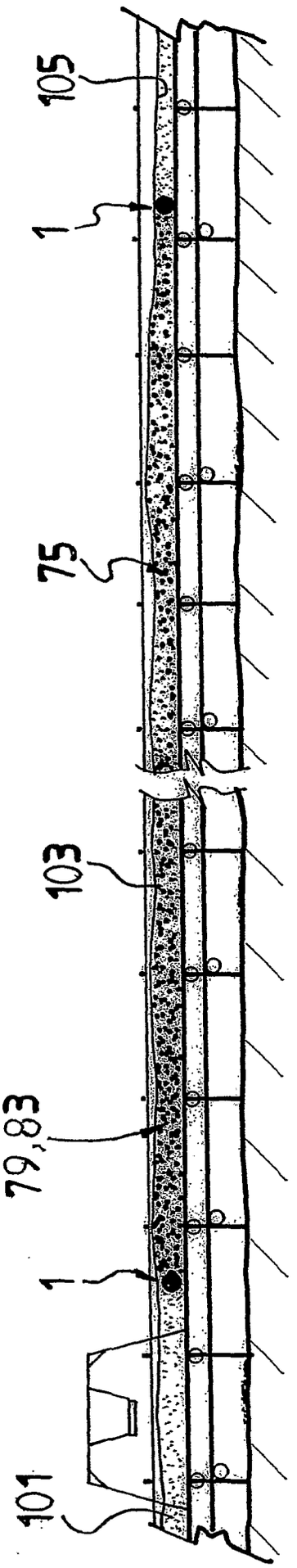

FIG 12

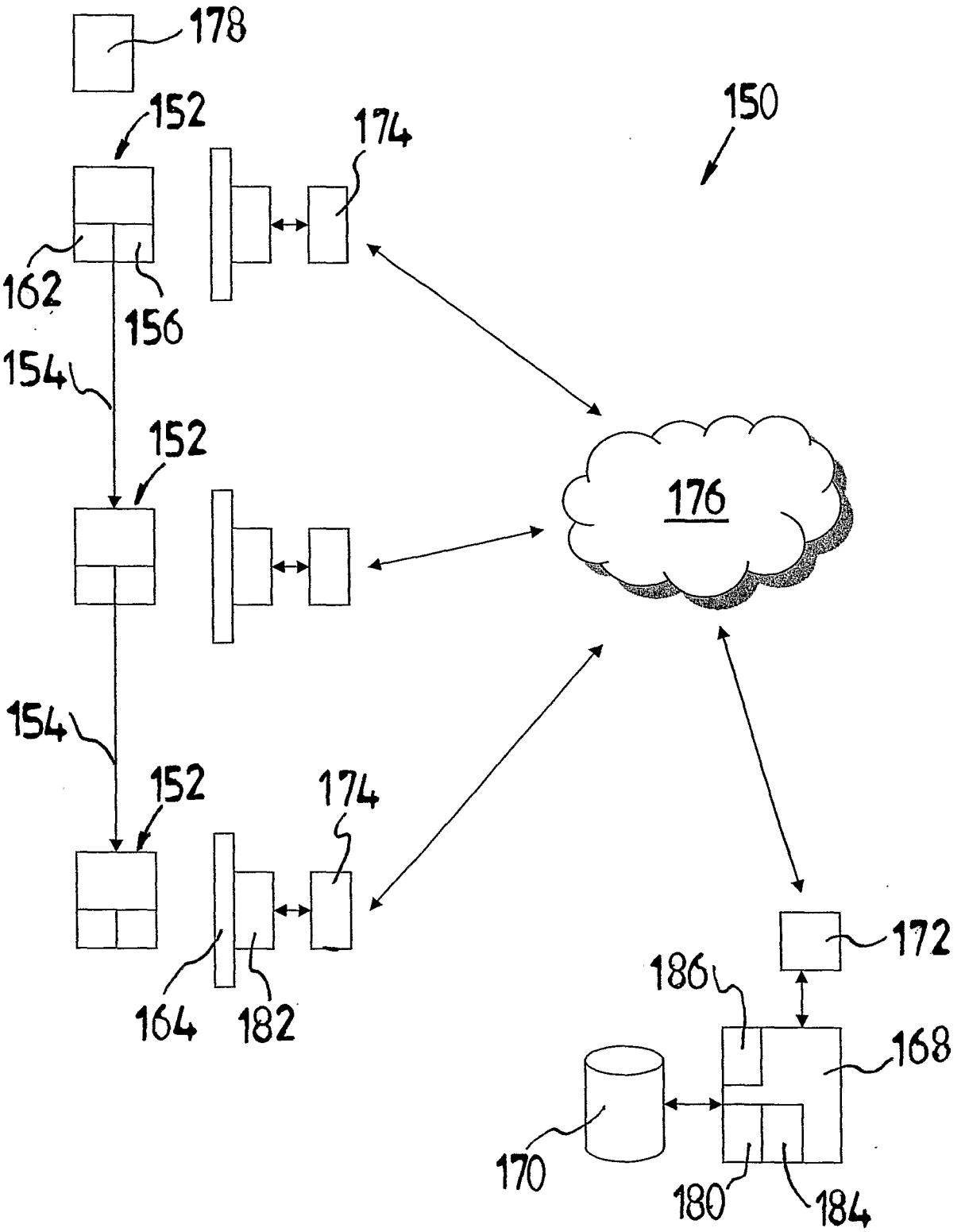
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FIG 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001299

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

G06F 7/00 (2006.01) ***G08B 13/14*** (2006.01)

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)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI: IPC as above plus keywords ***RFID, track, E21#/ic, transport, convey, tag, transpond**** and similar others

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AU 2003200413 A8 (VALIUKAS, et al) 28 August 2003 See entire document	1-75
X	US 2006/0169776 A1 (HORNBAKER et al) 3 August 2006 See abstract	1-75
A	Patent Abstracts of Japan JP 2006-183257 A (GRACE CHEMICALS KK) 13 July 2006 See abstract	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2007	14 NOV 2007
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **N. Stojadinovic** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : (02) 6283 2124

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2007/001299

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member			
AU 2003200413				
US 2006169776	US 7047103	US 7162328	US 2006004484	
	US 2006136093			
JP 2006183257				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX