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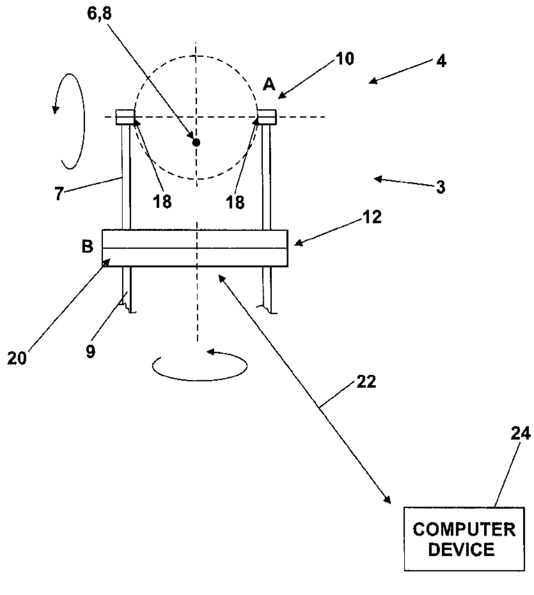

(57) Abstract: A measuring device (3) arranged to measure the distance between the measuring device (3) and a plurality of distributed points on a target object. The measuring device (3) includes an emitter (6) for emitting light or radiation at the target object, a receiver (8) for receiving the light or radiation reflected from the target object and a scanning system (4) arranged to rotate at least one of the emitter (6) and the receiver (8) through a plurality of full revolutions in a first plane and through at least approximately 360 degrees in a second plane, wherein the second plane is substantially perpendicular to. the first plane.

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DISTANCE MEASURING DEVICE AND METHOD

The invention relates to a measuring system, method and device for measuring the dimensions, shape or topography of a structure or object. In particular, it relates to a system, method and device for collecting data for producing a computer model of the structure or object, and if required its surroundings.

Electronic methods are known for obtaining distance measurement information. For example, a simple known device is an infrared measure that is used in the construction industry and by estate agents for measuring the floor plan of a building. The infrared measure is positioned adjacent to a wall in a room and an infrared beam is emitted from the device. The beam is reflected by an opposing wall and the device determines the distance between the walls by measuring the time taken to receive the reflected signal. The measured value can be stored in the memory of the device or alternatively may be recorded manually, for example on a pre-prepared drawing of the floor plan. By moving the infrared measure to appropriate locations around the room the distance between walls can be determined and the floor plan calculated.

More sophisticated systems are also known. For example scanning laser measuring devices are also available that scan the surfaces of the interior of a room and take a multiplicity of distance measurements. The distance measurements are stored electronically in a suitable data format that enables software to produce a three dimensional computer model of the room. Initially, a wire frame model is produced by making a suitable connection between the measured points and subsequently suitable surfaces/renderings/digital photographs can be applied to those surfaces within the model. However, a problem with this type of system is that there is no relationship between the measurements taken in a first room and measurements taken in subsequent rooms, and therefore it is necessary to make additional manual measurements and/or calculations in order to determine the building's layout. This considerably increases the time taken to produce the model of the building and may lead to inaccuracies and errors. In some instances, it is still necessary to produce diagrammatic layout maps to ensure that the measurement data for a particular room is correctly positioned within the computer model.

Some systems are known that make use of a scanning device with positional data, for example:

US 2002/0100884 teaches the use of a scanning head, which can be held by a user in order to produce a computer model of the object being scanned. However, a major drawback of this system is that the user has to sweep the scanner over the target object manually, alternatively use a robotic arm either automatically or with manual assistance in order to obtain measurements from all surfaces of the target object. However, with this system it is possible that the user may not cover the entire object and thus there may be gaps in the data model. Alternatively, there can be significant repetition as the user moves the scanning head leading to a very inefficient scanning process.

EP 1 441 236 discloses a scanning laser that is arranged to scan back and forth across a line wherein a surface can be scanned by movement of an aircraft flying forwards. The system is very limited since it is applicable to use in an aircraft.

GB 2403861 includes a similar scanning system which is mounted on the front of a train. This scanning system rotates in a single plane while the train moves along the track, for example within a tunnel to scan the inside of the tunnel. Again this device is very limited in the type of objects that can be scanned as it is only scanning in a single plane and relies on movement of the vehicle in order to scan a surface.

EP 1669766 discloses a hand-held scanner which a user can move to obtain measurement data from, for example the inside of a room. The problem with this type of scanner is that it is haphazard in the sense that it relies upon the user scanning the wall manually, which may produce significant gaps in the data model.

DE 1015983 discloses the use of a scanning system for use at crash sites. The device is arranged to determine the relative positions of vehicles and other objects at the site to provide a record of the events and also to help in the analysis of what transpired, and if necessary to provide evidence in a court case. This device only scans in a single plane, typically through an angle of 90 - 360°.

US 6,600,553 discloses a three-dimensional measuring device comprising a rotating 360° sensor head in a horizontal plane, with angular orientation in the vertical plane of between 60 - 120°. This system includes a telescoping mast, a rotating mirror and a laser ranging system and is mainly used to determine the layout of geological topographies. Its main limitation is its field of view for the vertical plane.

It is an object of the current invention to mitigate some of the afore-mentioned problems or to at least to provide an alternative arrangement to known devices.

According to one aspect of the invention there is provided a measuring device arranged to measure the distance between the measuring device and a plurality of distributed points on a target object, said measuring device including an emitter for emitting light or radiation at the target object, a receiver for receiving the light or radiation reflected from the target object and a scanning system arranged to rotate at least one of the emitter and the receiver through a plurality of full revolutions in a first plane and through at least approximately 360 degrees in a second plane, wherein the second plane is substantially perpendicular to the first plane.

This provides an efficient distance measuring device, which can be used in a measuring system that records the position of the measuring device when taking measurements for producing a three dimensional data model of the surroundings being scanned. The ability to rotate at least one of the emitter and receiver through multiple revolutions in one of the orthogonal planes enables the measuring system to produce a three dimensional model of its surroundings in a single scanning process very quickly, for example the boundaries of a room defined by the walls, ceiling and floor, without having to change the orientation of the device. It also has the advantage of reducing the number of times that the measuring device has to be repositioned to take measurements in order to scan the entire room. For simple rooms a single scanning process may suffice. Repeat measurements can be made quickly to improve accuracy. A processing device can determine more accurate measurements by averaging the measurements recorded.

Advantageously the scanning system can be arranged to rotate at least one of the emitter and receiver through full revolutions in the second plane.

Advantageously the scanning system can be arranged to rotate at least one of the emitter and the receiver continuously in at least one of the first and second planes. The emitter fires at a predetermined frequency during the scanning process to provide the desired number of data points. The resolution of the data model being determined by the number of data points recorded. This provides a very fast data gathering method. Preferably the scanning system is arranged to rotate at least one of the emitter and the receiver continuously in both the first and second planes.

Advantageously the scanning system can be arranged to step through arcs in at least one of the first and second planes when rotating, and the measuring device is arranged to take a measurements at predetermined intervals within the scanning sequence. For example, the emitter and/or receiver can be driven by a stepper motor or an electronically controlled servo motor and measurements can be taken when the emitter and /or receiver have been rotated through a predetermined arc.

Advantageously the emitter emits a beam of light or radiation. Preferably the measuring device is a line of sight measuring device that is arranged to scan in three dimensions. The light emitted can be in the visible spectrum or in an invisible spectrum.

Advantageously the emitter can include at least one laser device. Advantageously the receiver is arranged to receive light reflected from the target object. The distance from the measuring device to the target object can be calculated, for example by using the time of flight principle. Advantageously the laser device is arranged to fire laser pulses. The frequency of firing the laser device determines the number of measurements taken during a scan.

Advantageously the emitter can include a plurality of laser devices. This increases the rate of data collection and/or increases the accuracy of the laser measuring device since errors can be evened out by averaging the related measurements taken. For example, an average distance can be calculated by a processor device built into the measuring system or alternatively can be determined by software when the data is analysed.

Advantageously the laser measuring device can include a first laser operating at a first frequency and a second laser operating at a second frequency. For example, the lasers can be different diode lasers.

According to another aspect of the invention there is provided a measuring system including a measuring device according to any configuration described herein, a positioning system for determining the position of the measuring device when measurements are taken, and a storage device for recording distance and position data.

The invention enables a three-dimensional model of a structure to be generated from the measured data by moving the measuring device between measurement locations. For example, in a building the measuring device can be moved from room to room to determine the size and shape of each room. The relative positions of the rooms can be determined from the position data, which indicate the relative positions of the measuring device when distance measurements were made. Software can then be used to interpret the data in order to generate a computer model.

The measuring system can be used in other situations, for example to map/model the external shape or internal space of any structure, the internal space of a mine or tunnel, the topography of a landscape, or the relative position of vehicles, etc at a crash site.

The measuring system can be arranged to determine the position of the measuring device prior to taking any measurements such as when the measuring device remains static during the measurement process and / or when each measurement is taken for static and non-static embodiments.

Advantageously the positioning system can be arranged to determine the position of the measuring device in three-dimensions. This function enables, for example an accurate 3D data model to be created of a building having a plurality of floors since the positional data includes information regarding the relative heights of measuring positions and hence it is possible to determine the relative positions of different rooms within in a structure. This can be very important where level information cannot be obtained from another source or where the levels are irregular. Without level information, it would be impossible to produce an accurate three-dimensional data model of a building. In some simple cases, it may be possible to tweek the data model by hand, but even so this would only provide the modellers best guess, and in many circumstances the accuracy will not be sufficient. Furthermore adjusting a data model by hand is very time consuming.

Advantageously the positioning system is arranged to operate in a manner that allows the position of the measuring device to be determined through optically opaque objects.

Advantageously the positioning system can include a plurality of distributed position locator stations arranged to determine the position of the measuring device. For example, the position locator stations can be arranged to use the time of flight principle to locate the measuring device or triangulation. The positioning system includes a sufficient number of distributed position locator stations in order to determine the position of the measuring device in three-dimensions. For example, the system can include at least four position locator stations.

Advantageously each position locator station includes a transmitter and/or a receiver. The transmitter is used for sending signals to the measuring device for location purposes. Advantageously the transmitters operate at a frequency that enables the measuring device to be located when used in a substantially enclosed space, for example within a building. That is, the transmitted signals are arranged to pass through opaque objects such as the walls of the building and therefore the position system does not require the measuring device to be within the line of sight of the positioning system. The receiver can be used for receiving signals from the measuring device for location purposes.

Advantageously the system includes synchronising means for synchronising the operation of the position locator stations. This enables, for example, the position locator stations to transmit signals at substantially the same instant. The signals moving at the speed of light typically arrive at the measuring device at slightly different intervals due to the different distances over which the signal has to travel between each position locator station and the measuring device, and in some embodiments back to the position locator station. The distance between the position locator station and the measuring device can be determined by analysing the different arrival times of the signals. The combined data from each signal can be analysed by a processor to calculate the relative position of the measuring device in two or three-dimensions. For embodiments where the position locator stations do not move, the accuracy is very high and consistent. For example, the position locator stations may be connected together by wire, optical fibre or a wireless connection. However the position locator stations can move if they include means for determining the relative positions of the position locator stations one to the other which is integrated into the position calculation.

Advantageously the measuring device can include a transmitter and/or a receiver. For example, the measuring device can include a transmitter for sending signals to each of the position locator stations and a receiver for receiving signals therefrom.

Advantageously the data storage device can be located remotely from the measuring device and the measuring system includes a data transfer system for communicating measurement data to the data storage device. The data storage device can be located in a computer and may be any kind of conventional memory device such as RAM of a hard disk drive. The data transfer system can be a wireless connection such as WIFI or Blue Tooth® between the measuring device and / or position locator stations and the computer to store the data. Alternatively a data link such as a USB cable can be used. Data may be communicated from the measuring device to the position locator stations via their receivers. It will be apparent to the skilled person that at least one of the measuring device and the position locator stations can include memory devices to store data locally for later processing. It is also possible for at least one of the position locator stations and the measuring device to include a data processing device to process recorded data locally.

Advantageously the measuring device can include means for determining its orientation. This is particularly useful for embodiments of the invention that are hand held by a user during a scanning operation. The orientation data is recorded when each measurement is taken to account for the user accidently changing the orientation of the device during a scanning object.

According to another aspect of the invention there is provided a method of collecting geometric data about a structure or topography that can be used to produce a computer model of the structure or topography, including measuring the distance between a measuring device and a plurality of points on at least one surface of a target object, determining the positions of the measuring device when measurements are taken, and recording the distance and position data in a format that is suitable for processing to produce the computer model, wherein the measuring device is arranged to measure the distance between the measuring device and a plurality of distributed points on a target object, said measuring device including an emitter for emitting light or radiation at the target object, a receiver for receiving the light or radiation reflected from the target object and a scanning system arranged to rotate at least one of the emitter and the receiver through at least one full revolution in a first plane and at least one full revolution in a second plane, wherein the second plane is substantially perpendicular to the first plane.

The method may include moving the measuring device between stationary positions to scan a plurality of points on at least one other surface of the target object.

The method may include using a portable measuring device that is carried from room to room in a structure.

According to another aspect of the invention there is provided a measuring system including a measuring device for determining the distance between the measuring device and a plurality of points on a target object, a positioning system for determining the position of the measuring device when measurements are taken, and a storage device for recording distance and position data, wherein the positioning system is arranged to determine the position of the measuring device in three-dimensions and operates in a manner that allows the position of the measuring device to be determined through optically opaque objects.

The inventor has realised that a key disadvantage of prior art devices is there inability to determine relative positions of features of a structure in three dimensions, for example the positions of rooms on different levels within a building. The reason for this is that the location of the measuring device can only be determined in two dimensions and therefore the user has to account for different levels in some other manner, for example taking manual measurements. The present invention overcomes this shortcoming.

Advantageously the measuring device can be in accordance with any configuration described herein.

According to another aspect of the invention there is provided a method of collecting geometric data about a structure or topography that can be used to produce a computer model of the structure or topography, including measuring the distance between a measuring device and a plurality of points on at least one surface of a target object, determining the positions of the measuring device when measurements are taken using a positioning system, and recording the distance and position data in a format that is suitable for processing to produce the computer model, wherein the positioning system is arranged to determine the position of the measuring device in three dimensions.

According to another aspect of the invention there is provided a laser measuring device for determining the distance between the measuring device and at least one point on at least one surface of a target object including a first laser operating at a first frequency for determining a first measurement, a second laser operating at a second frequency for determining a second measurement.

Preferably the laser measuring device includes processing means for calculating an average measurement from the first and second measurements. This increases the accuracy of the laser measuring device. Preferably the first and second lasers are diode lasers, wherein the first diode laser is different from the second diode laser.

Advantageously the laser measuring device may include at least one further laser. The greater the number of lasers included in the system the more accurate the measurement.

Preferably the or each further laser is a laser diode that is different from the first and second laser diodes.

Advantageously the laser measuring device includes scanning means, and the first and second lasers are arranged to measure the distance between the measuring device and a plurality of distributed points on at least one surface of the target object.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 is a schematic diagram of first and second embodiments of the invention;

Figure 2 is a schematic of a measuring device for use in the first embodiment of the invention;

Figures 3a to 4b show schematically the scanning action of the first and second embodiments of the invention;

Figure 5 is a schematic of the measuring device in the first embodiment mounted on a stand; and

Figure 6 is a schematic of a measuring device for use in a second embodiment of the invention.

Figure 1 shows an electronic measuring system 1 including a distance measuring device 3 and four base stations 5 for determining the relative position of the distance measuring device 3 in three-dimensions when taking distance measurements.

The distance measuring device 3 includes a laser scanning device 4 that is arranged to measure the distance between the device and multiple points on at least one surface of a target object, for example boundary walls, ceilings and floors that define the size and shape of a room. The laser scanning device 4 is shown in Figure 2, and includes a laser 6 that is arranged to fire a laser pulse at the target object at a predetermined frequency and a sensor

8 that is arranged to receive reflected signals from the target object, wherein the distance between the measuring device 3 and the target object can be calculated from time of flight information, determined from a clock.

The laser 6 and sensor 8 are mounted in a frame 7. The frame 7 includes a first mechanism 10 that enables the laser 6 and sensor 8 to rotate continuously in a first plane and a second mechanism 12 that enables the laser 6 and sensor 8 to rotate continuously in a second plane that is substantially perpendicular to the first plane. That is the laser 6 and the emitter 8 can be rotated continuously through full revolutions of 360 degrees in the first plane while the second mechanism 12 continuously rotates the laser 6 and sensor 8 through at least one full revolution of 360 degrees in the second plane simultaneously. Since the laser 6 and sensor 8 are arranged to rotate continuously through full revolutions at a very high scanning rate it enables the surroundings to be scanned very quickly spherically / globally in substantially all directions. For example, substantially the entire interior of a room can be scanned in three-dimensions by the scanning mechanism. This enables repeat measurements to be made quickly to give continuous repetitive coverage, which enables later processing to average the readings or identify rouge readings to improve accuracy.

The first plane is typically a substantially vertical plane and the second plane is typically a substantially horizontal plane. For the purposes of a scanning process, it does not matter which of the planes the multiple revolutions occur in and which of the planes the single revolution occurs.

The first mechanism 10 includes a mounting member arranged substantially horizontally that is connected to the frame 7 by bearings. The laser 6 and sensor 8 are mounted on the member and are driven by a motor to revolve in the vertical plane continuously. The second mechanism 12 includes first and second mounting members 14,16 that are arranged substantially horizontally. The second mounting member 16 is fixed to a second frame member 18 and the first mounting member 14 is driven by a motor to rotate relative to the second mounting member 16. The frame 7 and hence the laser 6 and sensor 8 are mounted on the first mounting member 14 and are thus driven to revolve in the horizontal plane by the motor.

The first and second mechanisms 10,12 include slip transfer contacts 18,20 to enable transmission of emission stream data and return stream data from the laser 6 and sensor 8 respectively to a data transmission system 22 and then to a computer device 24 for data storage and later processing. The computer includes a memory device that may be of any suitable type, for example, Random Access Memory (RAM), memory that is transferable for example flash memory or a portable hard disk drive. Alternatively the memory device can be included in the measuring device 3 with some kind of suitable transfer means to the computer, for example a USB, serial or parallel port, or a wireless system such as WIFI, Blue Tooth®, radio technology or a network device, for example that communicates via a telephone network.

During the scanning process the laser 6 and sensor 8 are rotated continuously simultaneously, for example by one or more servo motors, with the laser 6 firing pulses at a predetermined rate. The firing rate determines the number of data points obtained, which determines the resolution of the data model and the processing time required to produce the data model.

Alternatively, the laser 6 and sensor 8 can be driven to revolve by an incrementally adjustable motor such as a stepping motor or an electronically controlled servo motor, to step through the scanning process in at least one of the planes. The resolution of the scanning steps is determined by the number of measurement positions within a 360° rotation of the laser 6. Preferably the resolution of the measurements is in the range 0.25° to 2° in both the vertical and horizontal planes. Other ranges may be more appropriate depending upon the nature of the article being measured. It is also possible to have the laser 6 and sensor 8 rotate continuously in one of the planes and to be stepped through arcs in the other plane.

The measuring device 3 includes an attachment for a stand 9. Thus the can be fitted to a stand 26 which can be moved between rooms after each scanning process. Thus, in this embodiment, the measuring device can be arranged to take measurements when stationary. When stationary, fewer position measurements may be required. For example, the position of the measuring device can be determined before distance measurements are made and that position data can be associated with each of the distance measurements taken until the measuring device is moved to another position. In subsequent rooms, the relative position can be established prior to taking further distance measurements and the new position data can be associated with the subsequent distance measurements. Alternatively, relative position measuring can be done on a continuous basis and associated with the distance measurements as they are taken. For continuous position measurement, the greater the frequency of position measurements taken the more accurate the position will be.

Each base station 5 includes a transmitter for emitting signals to the measuring device 3. Each base station 5 is synchronised such that the signals transmitted from the base stations are transmitted at substantially the same instant. The signals will arrive at a receiver in the laser device at slightly different times because the measuring device in most instances will be located at different distances from each of the base stations 5. From the timing information from each of the signals the relative position of the measuring device 3 can be determined. The position information is stored in the memory device together with the measurement data.

Preferably the measuring system includes at least three base stations 5 when providing a two-dimensional map, for example of a floor plan of a building and four base stations 5 when producing a three-dimensional model of a structure or topography. Being able to locate the measuring device 3 in three-dimensions can be very important some situations, for example when floors are on different or split levels at unknown heights. Also in some situations the floors between levels may slope irregularly and may change direction frequently.

In use, the base stations 5 are connected to each other either by wire (or optical fibre) or a wireless connection such as WIFI or Blue Tooth® and a synchronisation process is then initiated to ensure that each base station 5 transmits signals substantially simultaneously. Optionally, the measuring device can be synchronised with the base stations so that the time of flight of an emitted signal can be calculated to enable the distance between each base station 5 and the measuring device to be calculated. The base stations 5 are then distributed adjacent to the building to be modelled and are spaced apart. Preferably the base stations 5 are spread around the building though this is not critical. In this embodiment the base stations remain stationary throughout the process. The base stations 5 are activated to emit repeating signals. The particular frequency range chosen is such that signals can easily pass through the walls of the building being measured without significant degradation of the signals.

The user takes the measuring device 3 into the first room in the building and mounts it on top of a stationary stand 26. The receiver in the measuring device detects the signals transmitted from the base stations 5 and the differences in the time of arrival are recorded automatically so that it is possible to determine the relative position of the measuring device when measurements are made since the base stations 5 do not move. It is only necessary to determine the relative position of the measuring device each time it is moved within a room or between rooms. This of course assumes that the device will remain stationary for the entire scanning process. The user then initiates the measuring device 3 to scan the room with the laser measurement tool. The laser 6 emits pulses of radiation 3a-d during the scanning process to measure the distance of a multiplicity of points on the walls, ceiling and floor defining the boundary 11 of the room (see Figure 3).

The measurement data is stored in the computer device 24 together with the data determining the position of the device when each measurement was made. A full scanning process consists of the laser 6 and sensor 8 being rotated once through 360 degrees in the horizontal plane and being rotated through full revolutions multiple times in the vertical plane. Figures 3 and 4 illustrate this diagrammatically by showing segments representing the movement of the laser 6 and sensor 8, in particular Figure 4 shows rotational movement in the horizontal plane while the laser 6 and sensor 8 are continually rotated in the vertical plane (or vice versa). For example, the laser 6 and sensor 8 can be rotated once in the vertical plane for every one degree of rotation in the horizontal plane. Typically the laser 6 and sensor 8 are rotated once in the vertical plane for 0.1 to 3 degrees in the horizontal plane. The laser 6 and sensor 8 rotate in a single direction (clockwise or anticlockwise) in the vertical and horizontal planes, since this is the most efficient way of scanning. It will be appreciated that the scanning process could involve oscillatory rotating movement through an angle of slightly less than 360 degrees, for example in the vertical plane to avoid scanning the stand on which the measuring device 3 is mounted. While it is possible to arrange the device in this manner it is simpler and more efficient to perform full revolutions and remove the stand from the data model in due course.

If desired, the scanning process can be repeated to increase accuracy. This can be from the same position in the room or alternatively from a different position.

When the entire room has been scanned at least once the user moves the measuring device 3 into each subsequent room. The system measures the position of the measuring device 3 before or during a new scanning operation, as appropriate. The measuring device 3 records the measurement data for each subsequent room and the relative position of the measuring device when each measurement is made.

When all of the data has been recorded the data processed by a computer by inputting it into modelling software to generate a computer model of the building. The size and shape of each room is determined from the distance measurement data relating to each room and the relative position of each room is determined from the position data.

If desired rendering or digital photographs can be applied to the model to make the model more lifelike.

Figure 6 shows a second embodiment of the invention. The second embodiment is similar to the first embodiment except that it is arranged to be carried in the hand of a user instead of being mounted on a stand. This enables the user to walk between rooms, with the laser continuously scanning each room while the user carries the device. In this case, it is necessary to update the position data on a continuous basis, i.e. when each measurement is taken. In this embodiment the device also includes an orientation device 30, such as a gyroscopic device, for determining the orientation at which the device is held by the user. This enables the modelling software to allow for changes in orientation of the device during the scanning process. The orientation data is recorded together with the measurement and position data for later processing.

It will be appreciated by the skilled person that modifications can be made to the above embodiments that fall within the scope of the invention, for example one of the base stations 5 or an adjacent computer may include appropriate receiver means to receive transmission of the data either dynamically during a recording process or from a local memory device when a measuring process has been completed.

Instead of rotating the laser 6 and the sensor 8, it is possible in some embodiments that it will only be necessary to rotate one of those components. For example, if a sensor 8 is used that can receive signals from any direction then it may only be necessary to rotate the laser 6.

A plurality of scanning processes may be undertaken in a single room in order to better define a room having a complex shape. The recorded data can then be merged to produce an accurate model of the room. The measuring device 3 may include a multiple headed laser system with each laser mounted a number of degrees apart, and each having its own sensor, that enables an increased rate of data collection and enables error adjustment to be evened out by averaging the related measurements taken from the multiple head. This will further improve the accuracy of the device.

It will be appreciated by the skilled person that the relative positions of the measuring device 3 can be determined in many ways. For example, the system may be configured such that position is determined from a signal emitted from the measuring device to the base stations or a system wherein the base stations each include a transceiver device that is arranged to send signals to the measuring device and receive signals returned by the measuring device 3.

In other embodiments the base stations may move provided that the relative position of one to the other is established by sending signals between each of the base stations. This is then integrated into the calculation.

As an alternative to using the base station layout described above to provide relative positional data for the measuring device 3 when taking measurements, positional data from a satellite, or group of satellites, such as the Global Positioning System (GPS) could be used.

Another alternative that can be used to provide relative positional data for the measuring device 3 is known Radio Frequency Identification (RFID) – radar technology. This technology uses RFID tags, high gain pitch antennas and a processor unit that is capable of determining the position of the tag, which would be attached to the measuring device 3 via the signals received by the antennas. As the measuring device 3 moves the new position of the tag and hence the measuring device 3 is determined by the RFID system. The system works by measuring the distance a signal travels from a transponder to a reader. It measures the angle of arrival of the signal travelling from the transponder to the reader to give a position of location. The systems available can be used to measure positions in two or three dimensions. Some available systems have a relative position accuracy of around 1mm. For example, systems sold by Trolly Scan (Pty) Limited of South Africa can be used.

It is anticipated that the system may have applications for measuring the interior and exterior of a building using the same scanning process. This could be used for tax purposes on a building to determine its relevant size, for architects when designing buildings, quantity surveyors during the building process to establish that buildings are being produced in accordance with the plans, for estate agents who need to inform their client, for properties that are being sold or rented, for the purposes of obtaining data after an accident or incident, for determining external boundaries or a property, or for route finding at exhibitions. The device could also be used for surveying the topography of landscapes or mines.

Claims

1. A measuring device arranged to measure the distance between the measuring device and a plurality of distributed points on a target object, said measuring device including an emitter for emitting light or radiation at the target object, a receiver for receiving the light or radiation reflected from the target object and a scanning system arranged to rotate at least one of the emitter and the receiver through a plurality of full revolutions in a first plane and through at least approximately 360 degrees in a second plane, wherein the second plane is substantially perpendicular to the first plane.

2. A measuring device according to claim 1, wherein the scanning system is arranged to rotate at least one of the emitter and receiver through full revolutions in the second plane.

3. A measuring device according to claim 1 or 2, wherein the scanning system is arranged to revolve at least one of the emitter and the receiver continuously in at least one of the first and second planes.

4. A measuring device according to any one of the preceding claims, wherein the scanning system is arranged to step through arcs in at least one of the planes when rotating, and the measuring device is arranged to take measurements at predetermined intervals within the scanning sequence.

5. A measuring device according to any one of the preceding claims, wherein the emitter emits a beam of light or radiation.

6. A measuring device according to any one of the preceding claims, wherein the emitter includes at least one laser device.

7. A measuring device according to claim 6, wherein the emitter includes a plurality of laser devices.

8. A measuring device according to claim 7, wherein the laser measuring device includes a first laser operating at a first frequency and a second laser operating at a second frequency.

9. A measuring system including a measuring device according to any one of the preceding claims, a positioning system for determining the position of the measuring device when measurements are taken, and a storage device for recording distance and position data.

10 A measuring system according to claim 9, wherein the positioning system is arranged to determine the position of the measuring device in three-dimensions.

11. A measuring system according to claim 9 or 10, wherein the positioning system is arranged to operate in a manner that allows the position of the measuring device to be determined through optically opaque objects.

12. A measuring system according to any one claims 9 to 11, wherein the positioning system includes a plurality of distributed position locator stations arranged to determine the position of the measuring device.

13. A measuring system according to claim 12 when dependent on claim 9, wherein the positioning system includes a sufficient number of distributed position locator stations in order to determine the position of the measuring device in three-dimensions.

14. A measuring system according to claim 12 or 13, wherein each position locator station includes a transmitter and/or a receiver.

15. A measuring system according to any one of claims 12 to 14, including synchronising means for synchronising the operation of the position locator stations.

16. A measuring system according to any one of claims 9 to 15, wherein the measuring device includes a transmitter and/or a receiver.

17. A measuring system according to any one claims 9 to 16, wherein in the data storage device is located remotely from the measuring device and the measuring system includes a data transfer system for communicating measurement data to the data storage device.

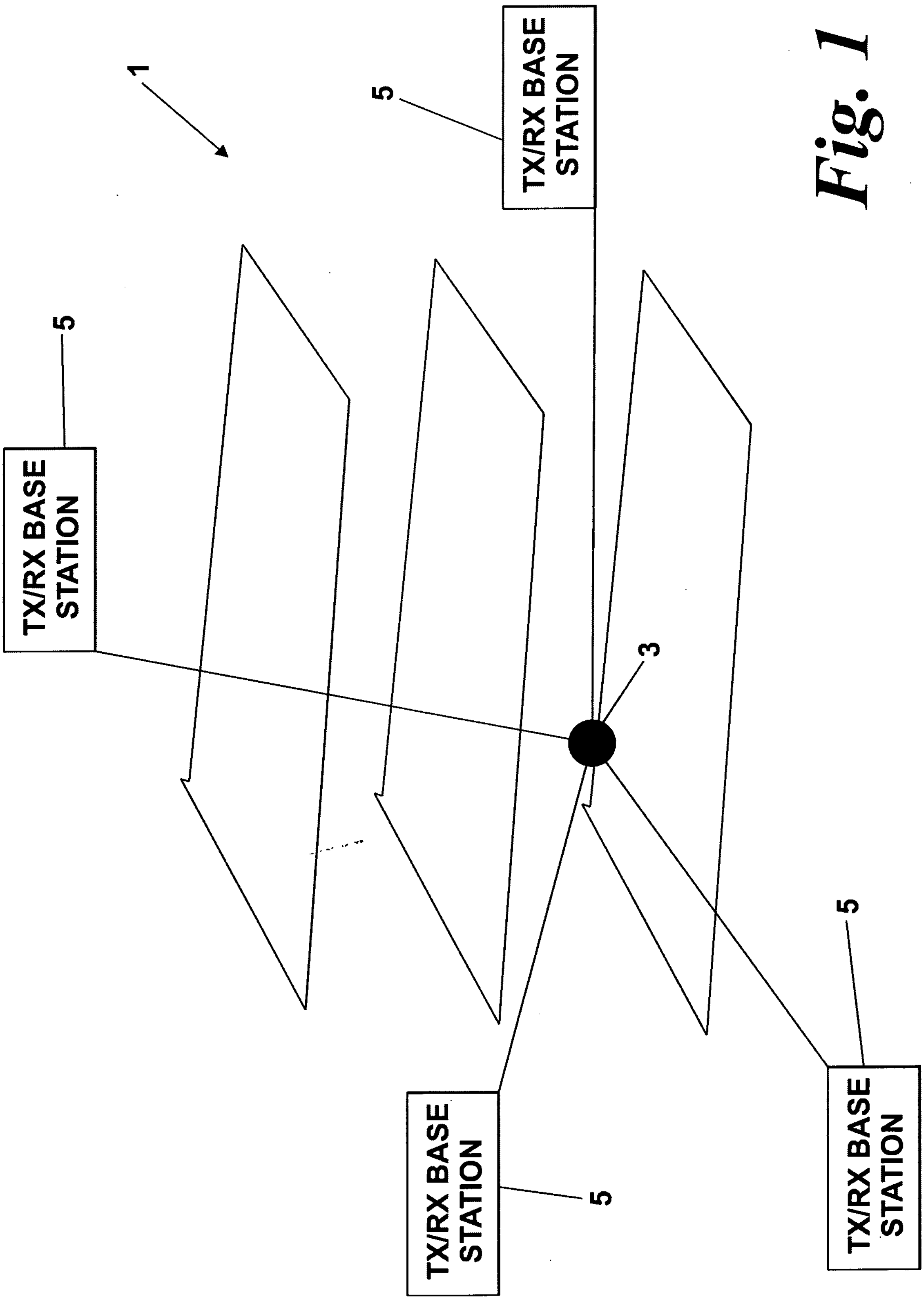
18. A measuring system according to any one of claims 9 to 17, wherein the measuring device includes means for determining its orientation.

19. A method of collecting geometric data about a structure or topography that can be used to produce a computer model of the structure or topography, including measuring the distance between a measuring device and a plurality of points on at least one surface of a target object, determining the positions of the measuring device when measurements are taken, and recording the distance and position data in a format that is suitable for processing to produce the computer model, wherein the measuring device includes an emitter for emitting light or radiation at the target object, a receiver for receiving the light or radiation reflected from the target object and a scanning system arranged to rotate at least one of the emitter and the receiver through at least one full revolution in a first plane and at least one full revolution in a second plane, wherein the second plane is substantially perpendicular to the first plane.

20. A method according to claim 19, including moving the measuring device between stationary positions to scan a plurality of points on at least one other surface of the target object.

21. A method according to claim 19 or 20, including using a portable measuring device that is carried from room to room in a structure.

22. A method according to any one of claims 19 to 21, including using a positioning system having a plurality of distributed position locator stations arranged to determine the position of the measuring device


1
5
TX/RX BASE STATION
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TX/RX BASE STATION
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TX/RX BASE STATION
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Fig. 1

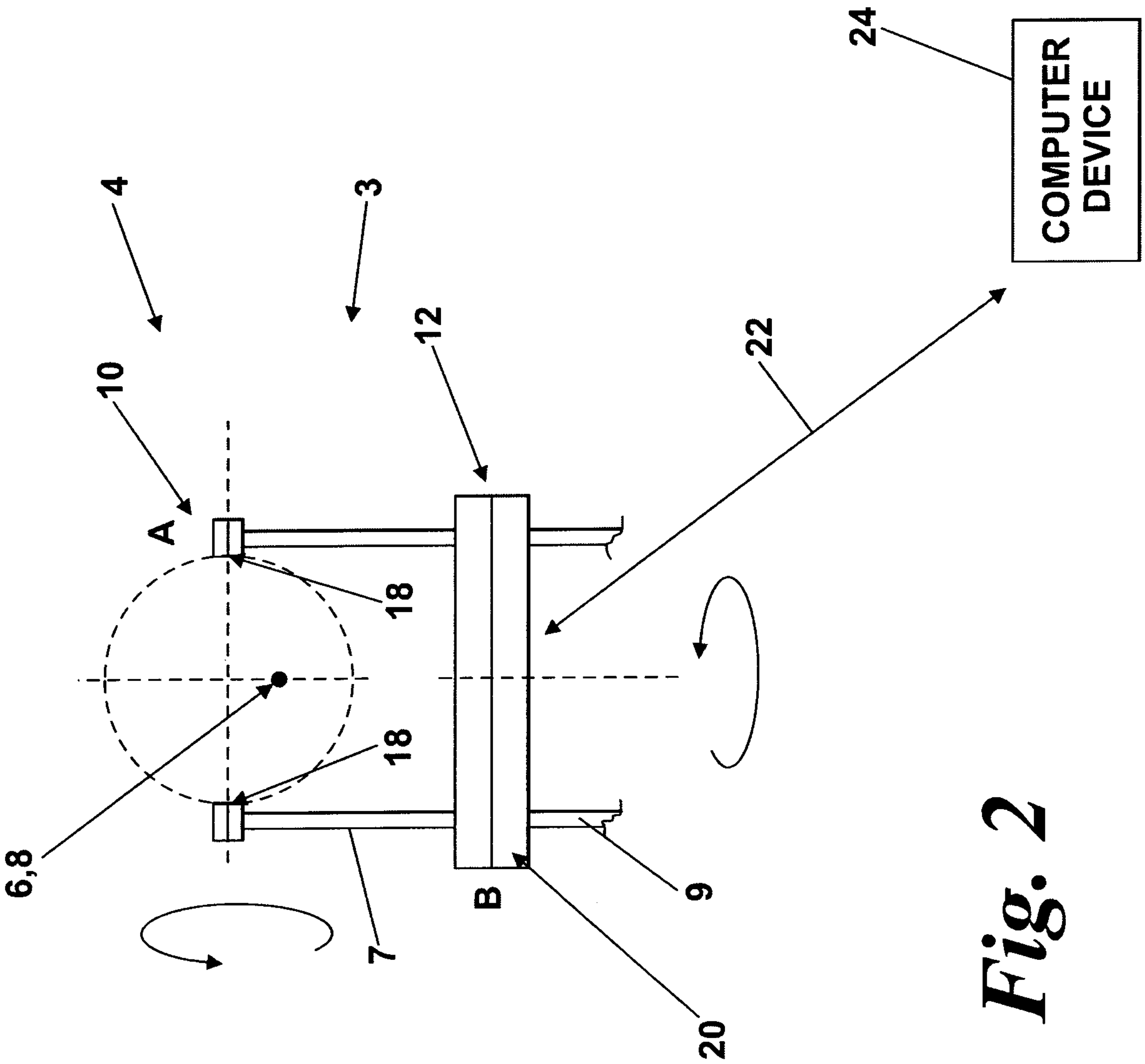

Fig. 2

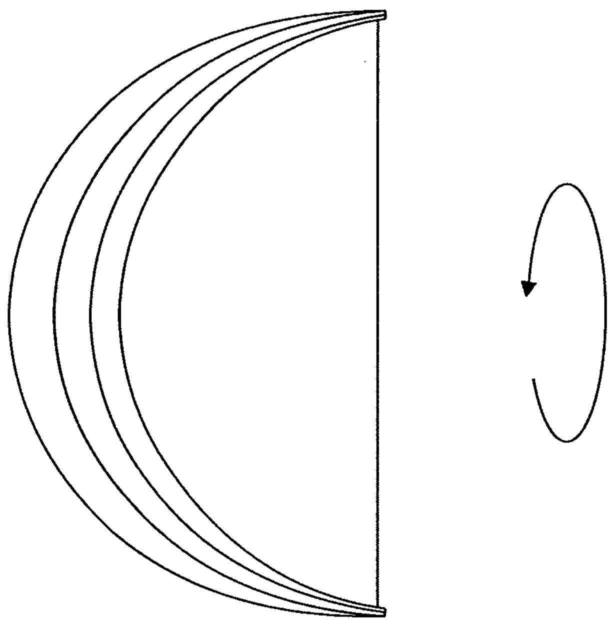

Fig. 3a

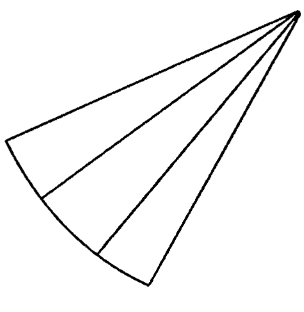

Fig. 3b

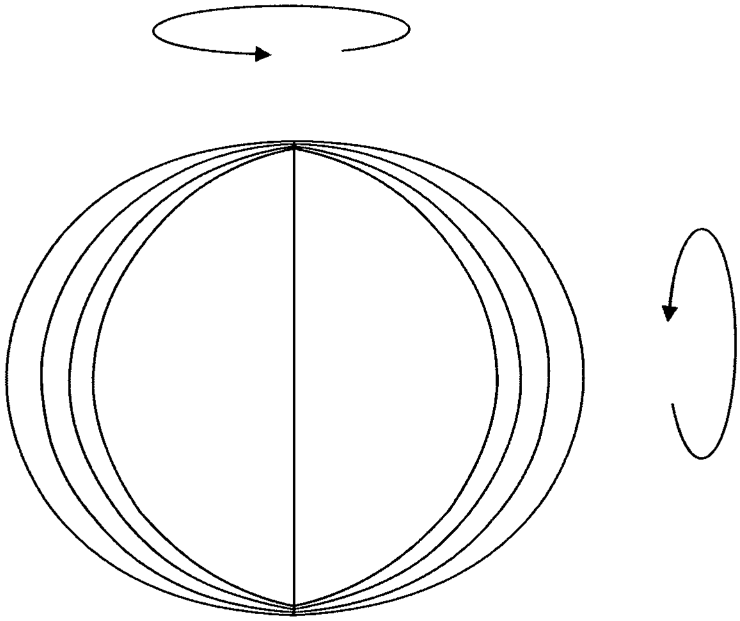

Fig. 4a

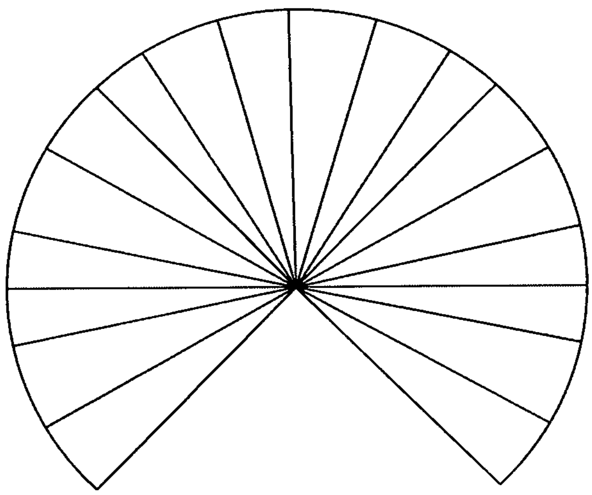

Fig. 4b

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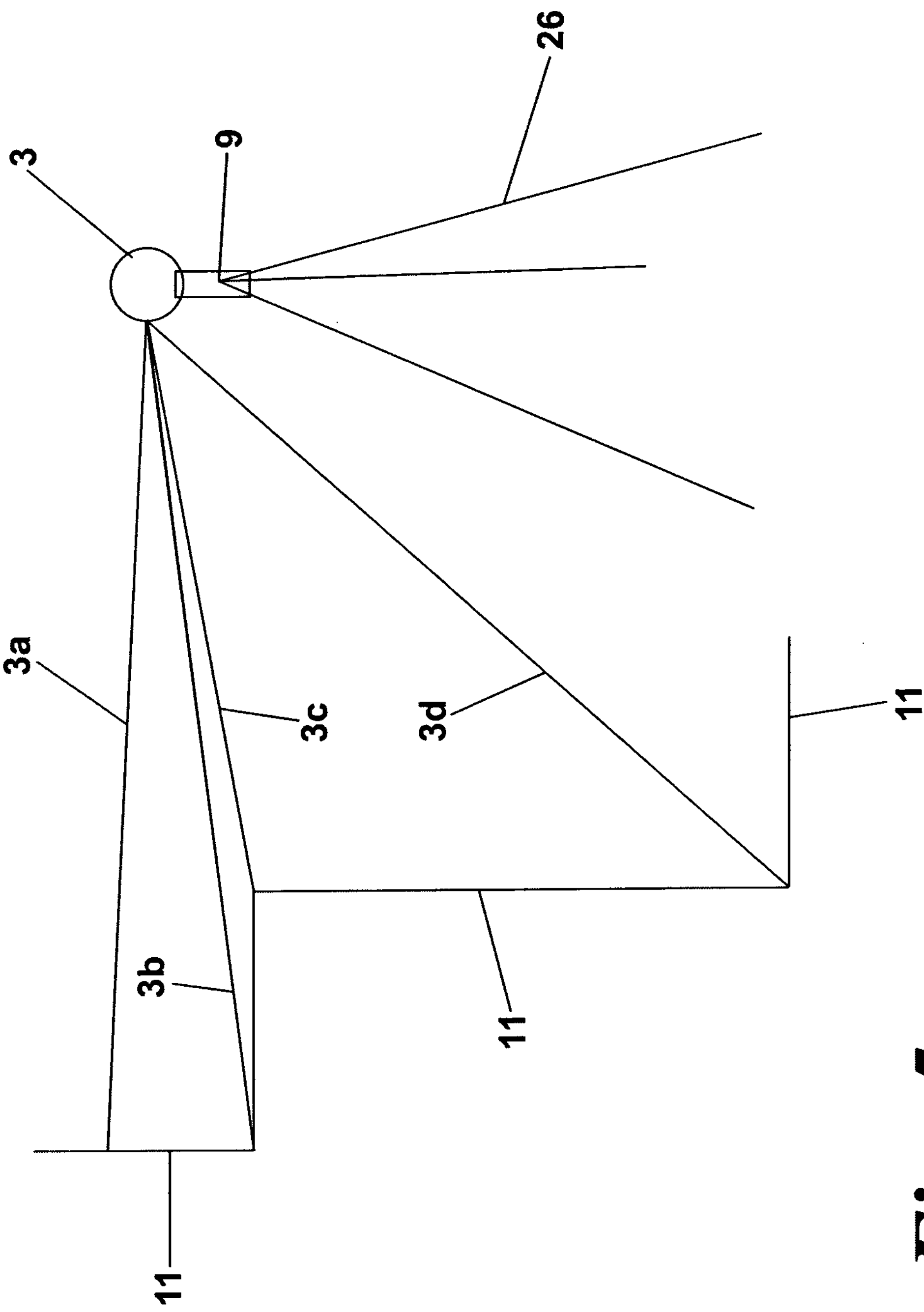

Fig. 5

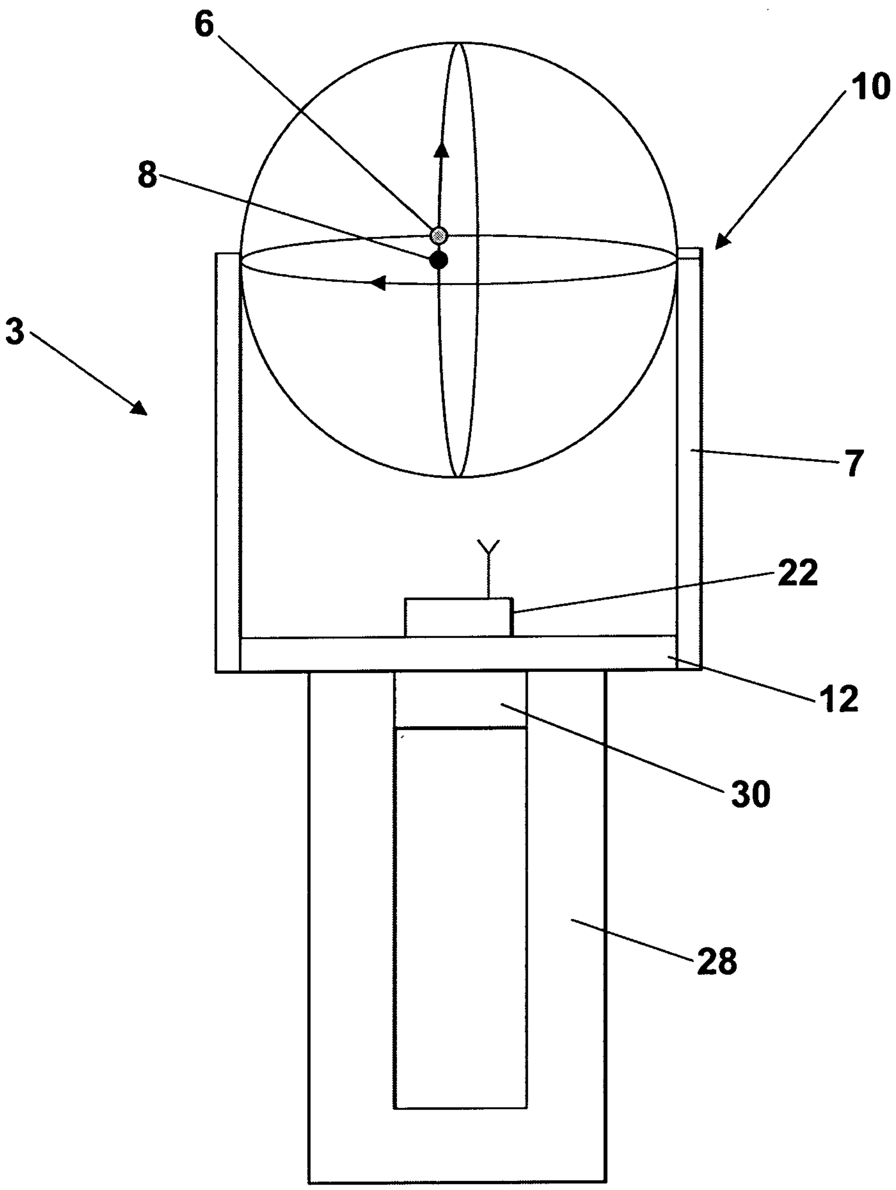

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/004403

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01B11/24 G01S17/08

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)
G01B G01S

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 practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/064273 A (FARO TECH INC [US]; OSSIG MARTIN [DE]; BECKER REINHARD [DE]; BECKER BE) 14 July 2005 (2005-07-14) page 2, lines 14-31 page 9, line 8 - page 10, line 2 page 12, lines 15-19 figure 1	1-21
X	EP 1 503 221 A (NIDEC CORP [JP]; HOKUYO AUTOMATIC CO [JP]) 2 February 2005 (2005-02-02) paragraph [0035] abstract	1-21
A	US 2003/043386 A1 (FROEHLICH CHRISTOPH [DE] ET AL) 6 March 2003 (2003-03-06) paragraphs [0019], [0028] figures 1-3	1-21

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"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

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Date of the actual completion of the international search: 27 March 2008

Date of mailing of the international search report: 04/04/2008

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Passier, Martinus

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CA 2 499 241 A1 (MAPTEK PTY LTD [AU]) 2 September 2006 (2006-09-02) abstract; claims 1,9; figure 1	1-21

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2007/004403

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			DE	10361870	A1	28-07-2005
			EP	1700085	A1	13-09-2006
			JP	2007517204	T	28-06-2007
			US	2006245717	A1	02-11-2006
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			JP	3875665	B2	31-01-2007
			JP	2005055226	A	03-03-2005
			US	2005024625	A1	03-02-2005
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CA 2499241	A1	02-09-2006	NONE			