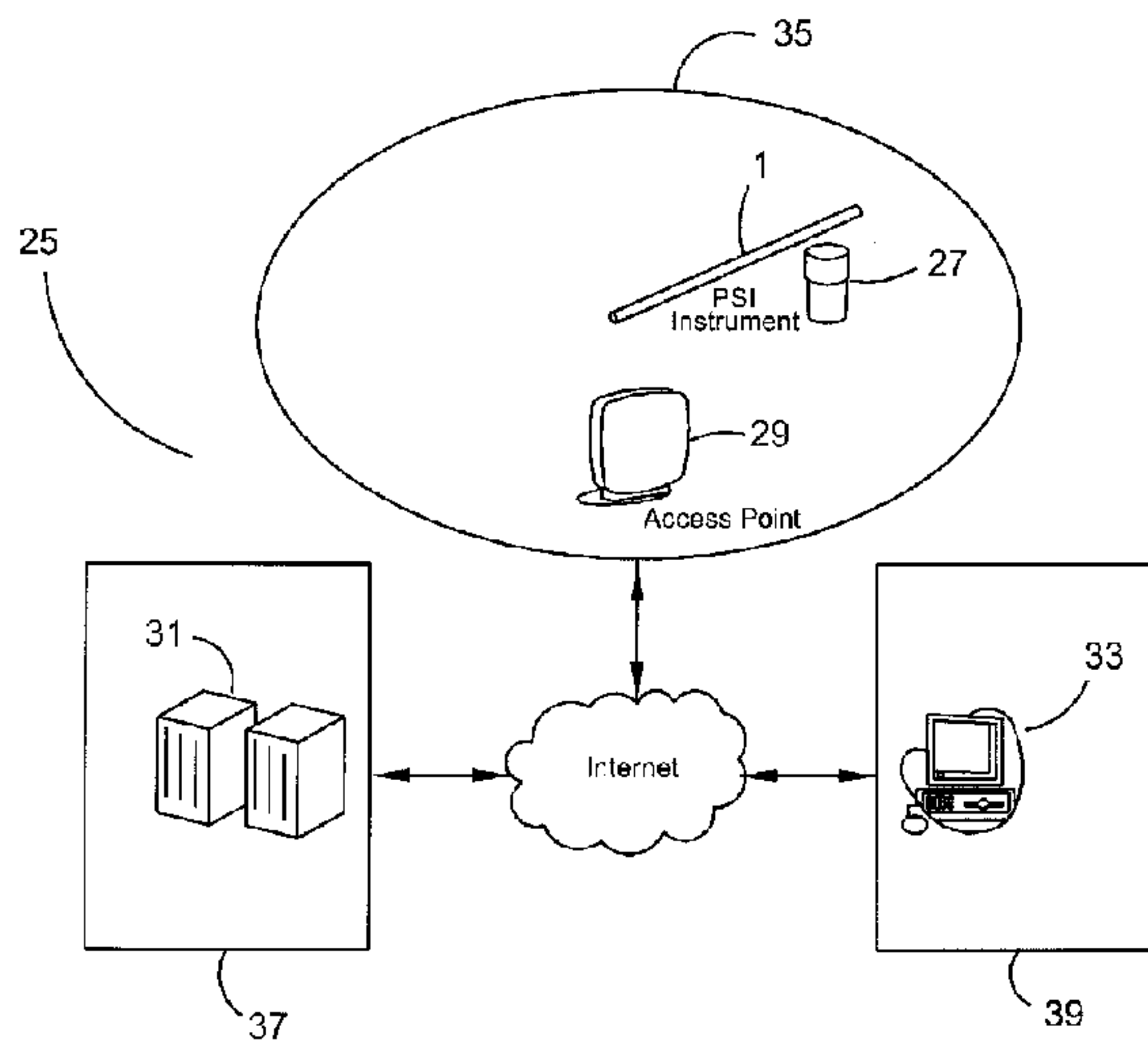




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(54) Title: DOWN-HOLE MONITORING AND SURVEY SYSTEM



(57) **Abrégé/Abstract:**

A drill-hole survey and geoscientific data acquisition system including a down-hole comprises a sensor control module, at least one sensor module, and data, control and electrical power connection means. The sensor control module, the at least one sensor module, and the connection means are sized and shaped to be placed within a drill-hole and to travel along the length of the drill-hole. The sensor control module and each of said at least one sensor modules are a discreet control modules. Each of the discreet control and sensor modules are inter-connectable via said data, control and electrical power connection means so that the series of modules are connected end to end to make one continuous elongate tool containing a series of interconnected modules. The sensor control module controls the tool and provides electrical power to, sends control signals to, and receives data from, each of the at least one sensor module.

Abstract

A drill-hole survey and geoscientific data acquisition system including a down-hole comprises a sensor control module, at least one sensor module, and data, control and
5 electrical power connection means. The sensor control module, the at least one sensor module, and the connection means are sized and shaped to be placed within a drill-hole and to travel along the length of the drill-hole. The sensor control module and each of said at least one sensor modules are a discreet control modules. Each of the discreet control and sensor modules are inter-connectable via said data, control and
10 electrical power connection means so that the series of modules are connected end to end to make one continuous elongate tool containing a series of interconnected modules. The sensor control module controls the tool and provides electrical power to, sends control signals to, and receives data from, each of the at least one sensor module.

DOWN-HOLE MONITORING AND SURVEY SYSTEM

Field of the Invention

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This invention relates to the equipment and system used to perform drill-hole survey and geological surveys of the sub-surface of earth, either onshore or offshore, wherein the equipment is given access to the subterranean strata by way of pre-prepared exploratory drill-holes.

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Background of the Invention

Geological surveys are critical activities used by mining and resource companies to determine the viability and operation of mines and wells. The accuracy and
15 timeliness of the acquired data is an important factor in finding the next big ore deposit, or oil or gas well. When it comes to geological surveying, time and precision are critical factors. Cost is an important factor as well. Lower cost surveys allow an operator to conduct more surveys within a set survey budget for a particular site.

20 It is common practice that a series of drill-holes are created so that professional geoscientists, such as geologists can use a variety of equipment and survey technology and techniques to get as much data as physically possible that relates to the subterranean strata deep within the Earth's crust at that location.

25 One of the problems associated with the practice is that these geological surveys are typically slow and costly to perform. The common practice is to have an on-site a drilling team that performs the drilling operation and creates the drill-hole, and then there is a survey team that subsequently works on the drill-hole with their equipment and performs the necessary geological survey. The survey team then returns to their
30 office with their collected data and start processing it to generate a survey report that mining or resource companies use to guide the planning and decision making relating to the operation of an existing asset, or the creation of a whole new operation.

Another problem associated with the common practice is that the tools and equipment used by the survey team are often highly specialised and complex, often requiring significant training and years of experience to operate correctly and effectively. In addition, the equipment is often expensive to maintain. Also there is currently only limited access to real-time data produced by the survey. Often this data is not analysed for days, weeks or months after the survey has been performed.

Ideally it would be best if the professional survey personnel were able to remain at the place where they are able to analyse and collate the survey data acquired as soon as possible after the survey operation has been completed and the data has been obtained.

Another problem is that drillers usually maintain a paper log of drill site activity, and this adds delays to the processing times of the geological survey data, and also adds delays to the processing of payments to the drillers for their work, and has the potential of introducing human error into the log.

Also geological survey personnel such as geologists often take an ad-hoc approach to the storage of the acquired geological survey data.

Due to the complexity and specialization of skills needed to effectively use the tools and equipment to conduct the survey, it is often not possible to have the drill operators perform the geological survey of a high and known quality, in addition to creating the drill-hole.

It is an object of the present invention to at least ameliorate some or all of the aforementioned problems.

Disclosure of the Invention

The present invention is a drill-hole survey and geoscientific data acquisition system that includes a down-hole tool including:

- 5 - a sensor control module,
- at least one sensor module, and
- data, control and electrical power connection means,

wherein the sensor control module, the at least one sensor module, and the connection means are each sized and shaped so that they can be placed within a drill-hole and can
10 travel along the length of the drill-hole, and can travel along the drill-hole. the sensor control module is a discreet control module, and each of said at least one sensor modules are also each a discreet sensor module, and each of the discreet control and sensor modules are inter-connectable via said data, control and electrical power connection means so that the series of modules are connected end to end to make one
15 continuous elongate tool that contains a series of interconnected modules. The sensor control module controls the tool and provides electrical power to, and sends control signals to, and receives data from, each of the at least one sensor module. The tool collects data along the drill-hole.

- 20 Preferably the tool collects geoscience data at discreet places along the drill-hole when the tool is stopped.

Alternatively the tool continuously collects geoscience data as the tool travels along the drill-hole.

25

Preferably the tool includes data transmission means that sends data up to the operator at the ground surface, and said transmission means is either wired or wireless.

- 30 Preferably the tool includes two wireless communication modes, one that is high powered, and the other that is low powered, and only one or the other is typically in operation at any one time.

Preferably the high powered mode is used to transfer a large amount of data as quickly as possible, such as firmware upgrades to the modules, and/or large amounts of sensor data, and is subsequently switched off when no longer required to preserve the tool's battery power reserves.

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Preferably the low powered wireless communications mode is used to send short quick commands back and forth from the tool, and when only small amounts of data need to be transferred.

10 Preferably the tool is capable of self-determining which wireless communication mode to use for any particular data transfer task, or the operator can manually select the wireless communication mode using remote commands.

15 Preferably the tool is capable of continuously transmitting said geoscience data back to the operator while the tool is down the drill-hole.

Alternatively the geoscience data can be collected and stored within the tool, and this collected data can then be uploaded into a handset by an operator after the tool has been retrieved from the drill-hole.

20

Preferably at least one gyroscope is included inside a discrete gyroscope module that is connected to, and forms a part of the elongate tool.

Alternatively at least one gyroscope is incorporated into the sensor control module.

25

Preferably the gyroscope is a microelectromechanical type gyroscope, also known as a MEMs gyroscope.

30 Preferably the gyroscope module includes four gyroscopes, and these are installed "nose to tail" so that the length of the gyroscope module is minimised.

Preferably each sensor module includes one or more types of sensor technology.

Typical sensor types used within a discrete sensor module include, but are not limited to:

- a. magnetic induction sensing, or
- 5 b. gamma ray sensing, or
- c. electrical resistance sensing, or
- d. acoustics sensing, or
- e. video surveillance, or
- f. temperature sensing, or
- 10 g. gravity gradiometer, or
- h. pressure sensing.

The down-hole tool is capable of being transported to the drill-hole site by the drilling operators in a disassembled condition, and the tool is capable of being assembled on-
15 site and accurately calibrated so that the tool includes all the appropriate modules required for any particular geoscientific survey to be performed on a particular drill-hole.

Preferably the tool can be disassembled and safely stored after the survey operation
20 has been completed by the drilling operators, ready to be transported to the next survey site.

Preferably the discrete modules are screwed together to form the elongate tool.

25 Preferably the sensor control module has the data transmission means at its end nearest to the opening of the drill-hole, and has data, control and electrical power connection means at the other.

30 Preferably each of the sensor modules and the gyroscope module has data, control and electrical power connection means at each end, and when each discrete module is screwed together with a neighbouring module, the data, control and electrical power connection is made between each module that makes up the tool.

Preferably the connection means includes an array of spring loaded electrical connector pins at one end, and a plurality of discrete electrical contacts at the other, so that when two modules are screwed together, the spring loaded pins of one module
5 are forced into electrical contact with a desired electrical contact on its neighbouring module.

Preferably each module includes a data logger that is relevant to that particular module.

10

Preferably each module includes the capability of shutting down power to its neighbouring module to preserve its own operational integrity.

Preferably the sensor control module includes a temperature sensor for the tool.

15

Preferably the sensor control module includes a tamper sensor that indicates if any of the modules have been tampered with.

Alternatively each of the modules that makes up the tool includes a tamper sensor that
20 indicates if the particular module has been tampered with.

Preferably the tool is capable of processing the data acquired by the sensors within the tool, so that the amount of data that is stored within the tool and transferred or transmitted from the tool is minimised.

25

Optionally at least one of the modules is filled with a suitable material such as oil to dampen the rate of variations in temperature which may adversely affect the efficacy or accuracy of the particular sensor.

30 Optionally the tool, including each module, and/or ancillary equipment, such as the handset, and/or associated software, includes digital rights management technology that can be remotely enabled or disabled by an authorised third party, such as a

distributor and/or owner of the tool, and wherein the tool, including each module, and/or ancillary equipment such as the handset, and/or associated software, can only be operated when the digital rights management technology is enabled.

5 In another form, the present invention is a down-hole survey system that uses the down-hole tool that has been previously described, and includes:

- a tool controller,
- an access point,
- at least one server, and
- 10 - a plurality of computers,

wherein the tool controller and the access point are located in the vicinity of the drill-hole. The tool controller is used to operate the tool, and collect the geophysical data acquired by the tool. This data is sent to the access point, and the access point is capable of wirelessly transmitting the acquired data over a wide area network, such as
15 the internet, to the at least one server and plurality of computers.

Preferably the tool controller is a ruggedised handset.

Preferably the access point is capable of creating a gateway between the local area
20 network at the survey site, and a wide area network, such as the internet, so that data to/from the down-hole tool, and/or to/from the handset, and/or to/from the at least one server, and/or to/from any one of the plurality of computers, passes via the gateway.

Optionally the access point is integrated into the ruggedized handset so that the
25 handset is capable of functioning as both the tool controller and the access point.

The present invention includes the arrangement where both the at least one server and at least one computer are geographically remote from the survey site.

30 Preferably the at least one server and the at least one computer in the plurality of computers are located within a master control facility, and at least one of the plurality of computers is located in a separate office remote from the master control facility.

Preferably the master control facility, both in conjunction with, or independently of, the separate office, prepares and dispatches a drilling program to a driller onsite, who will compare instrument data with a planned drill-hole plan so that the driller can
5 make any last minute adjustments to the drilling program.

Preferably the master control facility, either in conjunction with, or independently of, the separate office, is capable of using the survey data it receives from the survey site so that the drilling program and drill-holes can be analyzed.

10

Preferably the handset is capable of acquiring and transmitting data relating to the operational status and condition of the tool so that either or both the operator at the drill-hole site or the professional personnel at the master control facility are alerted if/when critical aspects of the tool has fallen out of proper calibration, or has in some
15 other way moved outside of acceptable operational parameters for the particular survey operation being undertaken.

Preferably personnel at the master control facility can react to alerts relating to critical aspects of the tool falling out of proper calibration, or in some other way has moved
20 outside of acceptable operational parameters for a particular survey operation, by sending corrective and/or instructional data back to the drill site, including firmware for the hardware, and/or updated associated software, in order to attempt to get the tool, or an included module within the tool, back into proper calibration, and/or back to within acceptable operational parameters for that particular survey operation being
25 undertaken, or to upgrade the equipment so that it operates at peak efficiency.

Preferably an authorised third party, such as a distributor and/or owner of the tool, including each module, and/or ancillary equipment such as the handset, and/or associated software, can enable or disable the digital rights management technology
30 associated with that equipment and associated software, depending on the licence status of the operator at the time that the operator is preparing to use the equipment and/or associated software to perform a survey on a drill-hole.

Preferably the handset has a simplified user interface that enables and empowers a driller at the survey site to perform highly specialised and complex survey activities under the supervision and instruction of professional geological survey experts, such as geologists, located at the master control facility, or at a remote office, thereby giving the professional survey experts virtual access to the drill site and remote oversight of the survey operation for any particular drill-hole survey operation being undertaken.

10 **Brief Description of the Drawings**

Figure 1 is an exploded isometric view of a tool having a control module, a gyroscope module and a sensor module.

15 Figure 2 is an isometric view of the electrical power, control and data connection means.

Figure 3 is a side cut away view of the gyroscope module showing four gyroscopes installed.

20

Figure 4 is a schematic of the complete survey system including the tool.

Detailed Description of the Preferred Embodiments

25 Turning firstly to Figure 1 we see an exploded view of the down-hole survey tool 1. The survey tool 1 can be assembled from a sensor control module 3 and a gyroscope module 13, and a plurality of sensor modules, selected from a kit containing a wide variety of sensor module types. Starting with the sensor control module 3, typically the gyroscope module 13 is connected to the sensor control module 3 via the external and internal screw thread pair 5 and 7 respectively. Each module has matching
30 internal and external screw threads, thereby enabling the tool to be assembled in a

wide variety of configurations. A different selection of sensor modules are assembled together for each specific survey task.

The sensor control module 3 is the master controller for the device. It includes the power supply for the tool, as well as the controller and monitoring means for each other module in the tool assembly. In addition, the sensor control module 3 includes data receiving and transmitting means. An example of suitable means is the wireless data receiving/transition means 11. As an alternative to wireless means, the sensor control module could also communicate with the ground surface via a wire.

10

In another preferred embodiment, the tool may incorporate two wireless communication modes. The first is a high power mode that is capable of sending and receiving comparatively large amounts of data more quickly and effectively. The other mode is a low power mode, and this mode is suitable for small amounts of data transfer. Typically only one mode is in operation at any one time. Because the high power mode consumes more power from the battery power reserves for the tool, it is only switched on when needed, and at other times it is turned off. The tool is capable of self-determining which mode it needs to use based on a variety of factors, such as the amount of data to be transferred, and/or whether there is enough power in the battery to be able to be used. In addition to this, either the driller, or a remote operator can remotely command the tool to use one mode or the other.

The end of the sensor control module 3 furthest from the opening of the drill-hole includes a set of electrical contact rails. When a module is screwed onto the sensor control module, and electrical connection is made between them. This electrical connection permits the flow of data, electrical power and control signals throughout the tool.

Within the scope of the present invention, the sensor control module may also include one or more gyroscopes. In this embodiment, there is no need to have a separate gyroscope module 13. In another embodiment, the sensor control module 3 may also include a sensor, such as a temperature sensor, thereby removing the need for

including a temperature sensing module in the tool. In yet another embodiment, the sensor control module 3 may include a tamper alert sensor that is capable of alerting the operator or owner of the tool to an unauthorised tamper event on any of the modules of the tool.

5

In another embodiment, some or all the modules include a respective tamper alert sensor that alerts the operator or owner of the tool of an unauthorized tamper event on any of the respective modules of the tool.

10 Each sensor module 15 is capable of doing at least one specific sensor or survey task, including, but not limited to:

- magnetic induction sensing
- gamma ray sensing
- electrical resistance sensing
- 15 • acoustics sensing
- video surveillance
- temperature sensing
- gravity gradiometer
- pressure sensing

20 Each sensor module may operate either autonomously, or may be controlled by the control module. Sensor data collected by a particular sensor module may either be stored locally in that particular sensor module, or the data may be stored in the control module, or a combination of both for the sake of redundancy.

25 Each module within the tool 1 includes a data logger.

Turning to Figure 2, we are shown opposite ends of a sensor module. We can see that there is an array of multiple spring loaded connector pins 17 at one end, and a plurality of concentric electrical contact rails 19 at the other. When two modules are
 30 screwed together, the spring loaded connector pins are forced into electrical contact with the electrical contact rails 19. Depending on the requirements for that particular

module, the pins 17 are arrayed so that only the appropriate contact rails 19 are connected to.

When the tool is assembled, it becomes a rigid elongate tool that is dimensioned to be lowered down the drill-hole. In another form of the invention, small bendable connectors are located between each module, thereby allowing individual modules to bend with respect to its neighbor. This assists in special circumstances where the tool needs to pass around a bend in the drill-hole that is would otherwise not be capable of passing in its rigid form.

10

Turning to Figure 3 we can see a cut away side view of the gyroscope module 13. In this embodiment we can see that it includes four MEMs type gyroscopes. The internals for the entire gyroscope module are capable of turning under the influence of a motor. The internals of the module are connected at each end to the bearings 23. The more gyroscopes that are installed in the tool thereby gives the tool a capability to reach an acceptable level of directional orientation precision in a shorter period of time, compared to a tool with fewer gyroscopes installed.

In a preferred embodiment, up to four MEMs gyroscopes are used inside the gyroscope module, and these are installed in a “nose to tail” configuration so that the length of the gyroscope module is considerably reduced.

In an alternative embodiment, it is possible that some, or all of the individual modules used in the tool are filled with a suitable substance, such as an oil, so as to dampen the rate at which temperature varies within the tool. Some efficacy and/or accuracy of some types of tools is degraded if it is subjected to temperature variations.

Turning to Figure 4 we are shown a schematic of the down-hole survey system 25 that uses the down-hole tool 1 as previously described. The system includes the down-hole survey tool 1, a handset 27, an access point 29, at least one server 31. The access point 29 acts as a gateway between the local area network 35, and the wide area network, such as the internet, that connects to the remote server 31 and the computer

30

33. In a preferred embodiment, the server 31 is remotely located from both the survey site and the computer 33. Preferably the server is located inside a Master Control Facility 37 that can be physically located anywhere in the world. The computer 33 is located at a client survey office 39, also located anywhere in the world. Geophysical scientists, such as geologists can be located at either facility and can oversee and run survey remotely from the survey site. There is a high degree to communications flexibility designed within the system. The down-hole tool 1 is can be configured to communicate directly with the access point 29, or via the handset 27 to the access point, and also it can be configured to communicate directly with the computer 33 or the server 31.

Additionally the master control facility 37 can monitor and maintain the equipment at the survey site in real time. If the module issues an alert that one or more of the modules have gone out of acceptable operational limits, the master control facility 37 can send back corrective instructions to the tool, and/or send instructions to the drilling operator about how to correct the problem.

The master control facility 37 enables the geophysical professionals to remotely plan and control the drilling program for the client at a particular survey site. At the commencement of a survey, the survey plan would be sent via the wide area network link to the handset and down-hole tools onsite. The handset, or in some cases a laptop computer or tablet that is being used by the driller will compare the instrument data with the planned survey data and provide guidance to the driller on parameters such as actual drill-hole deviation from planned direction to suit the specific geology of the survey location. A client company, such as a geoscience laboratory, at their office 39, can also enter in assay or other relevant information into the server records relating to the particular survey.

Furthermore, the master control facility can perform analytics based on the geo-location of the survey and the theoretical accuracy of the down-hole tool based on its location on the earth can be accounted for. This is required because Gyroscopic based sensors change accuracy depending on the latitude at which they are used, while

Magnetics tools require declination corrections to calculate true north depending on the latitude and longitude.

The other main aspect of the invention is that a user, such as a drilling contractor, or a mine site, can create a local area geophysical data network in a region by installing an access point 29 and that allows the down-hole tool and/or handset to directly and wirelessly communicate with both the master control facility's server, and/or client survey office 39.

10 In another form of the present invention, the access point 29 is incorporated into the handset, so that the handset also performs the function of the access point.

Another important aspect of the invention is that down-hole tool 1 undertakes the majority of the sensor data processing and thereby reduces the amount of data that needs to be transferred to the handset. This reduces the processing required on the handset, and reduces the amount of data to be transmitted to the handset from the instrument, and to the master control facility server 31. For the user at the survey site, it offers them a simple handset which is very easy to use, and requires minimal training, thereby allowing a drilling contractor to also perform the physical operations required to perform the survey.

Another important aspect of the invention is that the owner and/or distributor of the tool, ancillary equipment, and associated software, can remotely upgrade or service it as required so that the tool and its ancillary equipment and associated software can function at peak efficiency. Upgrades include updated software, or firmware for relevant hardware used either in or associated with the tool.

In another aspect of the invention, at least some of the modules, and/or the ancillary equipment such as the handset, and any associated software, has digital rights management technology incorporated with it. When the digital rights management technology is activated, the tool, and ancillary equipment, is in a usable condition. When the digital rights management technology is disabled, the tool and/or ancillary

equipment is in a non-usable condition. Furthermore the distributor and/or owner of the tool is able to remotely enable or disable the digital rights management technology. This arrangement thereby enables the distributor and/or the owner of the tool and ancillary equipment to lease/rent out the equipment to an operator and ensure
5 that it can only be used when the operator is in compliance with their relevant lease/rental agreement.

There are also other significant advantages to the system of the present invention. Under current practice, drillers maintain a paper log of drill site activity. This manual
10 process introduces delay into the processing and payment times for the field services they have provided. Under this system, payments to the drillers for their field services can be processed much quicker.

Finally, by having the data collected by the tool sent directly from the drill-site to the
15 remote office, the integrity and security of the data kept more secure.

The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

20 It will be also understood that where the word “comprise”, and variations such as “comprises” and “comprising”, are used in this specification, unless the context requires otherwise such use is intended to imply the inclusion of a stated feature or features but is not to be taken as excluding the presence of other feature or features.

25 The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that such prior art forms part of the common general knowledge in Australia.

Claims

1. A down-hole tool including:

- a sensor control module,
- at least one sensor module, and
- data, control and electrical power connection means,

wherein the sensor control module, the at least one sensor module, and said connection means are each sized and shaped so that they are adapted to be placed within a drill-hole, and are adapted to travel along the drill-hole, and wherein the sensor control module is a discreet control module, and each of said at least one sensor modules are also each a discreet sensor module, and each of the discreet control and sensor modules are inter-connectable via said data, control and electrical power connection means so that the series of modules are connected end to end to make one continuous elongate tool that contains a series of interconnected modules, and wherein the sensor control module controls the tool and provides electrical power to, and sends control signals to, and receives data from, each of the at least one sensor module, and wherein said tool collects data along the drill-hole, and wherein the tool collects geoscience data at discreet places along the drill-hole when the tool is stopped, and wherein the tool continuously collects geoscience data as the tool travels along the drill-hole, and wherein the tool includes data transmission means that sends data up to an operator at the ground surface, and said transmission means is either wired or wireless, and wherein the tool includes two wireless communication modes, one that is high powered, and the other that is low powered, and only one or the other of the two modes is in operation at any one time.

2. A down-hole tool as claimed in claim 1, wherein the high powered mode is used to transfer a large amount of data in the shortest possible time .
3. A down-hole tool as claimed in claim 2, wherein any firmware upgrades to the modules is delivered by the high powered mode, and is subsequently switched off when no longer required, to preserve the tool's battery power reserves.

4. A down-hole tool as claimed in claim 2, wherein large amounts of sensor data may be transferred by the high powered mode, and is subsequently switched off when no longer required, to preserve the tool's battery power reserves.
5. A down-hole tool as claimed in claim 1, wherein the low powered wireless communication mode is used to send short quick commands back and forth from the tool, and when only small amounts of data need to be transferred.
6. A down-hole tool as claimed in claim 1, wherein the tool is adapted to self-determine which wireless communication mode to use for any particular data transfer task, or is adapted to be remotely overridden and manually selected by an operator using remote commands.
7. A down-hole tool as claimed in claim 6, wherein the tool is adapted to continuously transmit said geoscience data back to the operator while the tool is down the drill-hole.
8. A down-hole tool as claimed in claim 7, wherein said geoscience data can be collected and stored within the tool, and this collected data can then be uploaded into a handset or any other authorized data receiver, either automatically, or manually by an operator, after the tool has been retrieved from the drill-hole.
9. A down-hole tool as defined in claim 8, wherein the at least one gyroscope is included inside a discrete gyroscope module that is connected to, and forms a part of the elongate tool, and said gyroscope module provides the tool with directional orientation information relative to a set reference point.
10. A down-hole tool as defined in claim 9, wherein the set reference point is true North.
11. A down-hole tool as defined in claim 8, wherein the at least one gyroscope is incorporated into the sensor control module.

12. A down-hole tool as defined in claim 9 or 11, wherein the gyroscope is a microelectromechanical type gyroscope, also known as a MEMs gyroscope.
13. A down-hole tool as defined in claim 9 or 11, wherein the gyroscope module includes four gyroscopes, and these are installed “nose to tail” so that the length of the gyroscope module is minimised.
14. A down-hole tool as defined in claim 8, wherein each sensor module includes one or more types of sensor technology.
15. A down-hole tool as defined in claim 14, wherein typical sensor technologies include, but are not limited to:
 - magnetic induction sensing, or
 - gamma ray sensing, or
 - electrical resistance sensing, or
 - acoustics sensing, or
 - video surveillance, or
 - temperature sensing, or
 - gravity gradiometer, or
 - pressure sensing.
16. A down-hole tool as defined in claim 15, wherein the tool is adapted to be transported to the drill-hole site by drilling operators in a disassembled condition, and the tool is adapted to be assembled on-site and accurately calibrated so that the tool includes a specific combination of modules required for a particular drill-hole at the drill-hole site.
17. A down-hole tool as defined in claim 16, wherein the tool is adapted to be disassembled and safely stored after use by the drilling operators, ready to be transported to the next drill-hole site.

18. A down-hole tool as defined in claim 17, wherein the discrete modules are screwed together to form the elongate tool.
19. A down-hole tool as claimed in claim 18, wherein the sensor control module has the data transmission means at its end nearest to an opening of the drill-hole, and has said data, control and electrical power connection means at the opposite end of the module.
20. A down-hole tool as claimed in claim 19, wherein each of the sensor modules and the gyroscope module has data, control and electrical power connection means at each end, and when each discrete module is screwed together with a neighbouring module, said data, control and electrical power connection is made between each module that makes up the tool.
21. A down-hole tool as claimed in claim 20, wherein the connection means include an array of spring loaded electrical connector pins at one end, and a plurality of discrete electrical contacts at the other, so that when two modules are screwed together, the spring loaded pins of one module are forced into electrical contact with a desired electrical contact on its neighbouring module.
22. A down-hole tool as claimed in claim 21, wherein each module includes a data logger that is relevant to that particular module.
23. A down-hole tool as claimed in claim 22, wherein each module is adapted to shutting down power to its neighbouring module to preserve its own operational integrity.
24. A down-hole tool as claimed in claim 23, wherein the sensor control module includes a temperature sensor for the tool.
25. A down-hole tool as claimed in claim 20 or 21, wherein the sensor control module includes a tamper sensor that indicates if any of the modules have been tampered with.

26. A down-hole tool as claimed in claim 20 or 21, wherein each of the modules that makes up the tool includes a tamper sensor that indicates if the particular module has been tampered with.
27. A down-hole tool as claimed in claim 22 or 23, wherein the tool is capable of processing the data acquired by the sensors within the tool, so that the amount of data that is stored within the tool and transferred or transmitted from the tool is minimised.

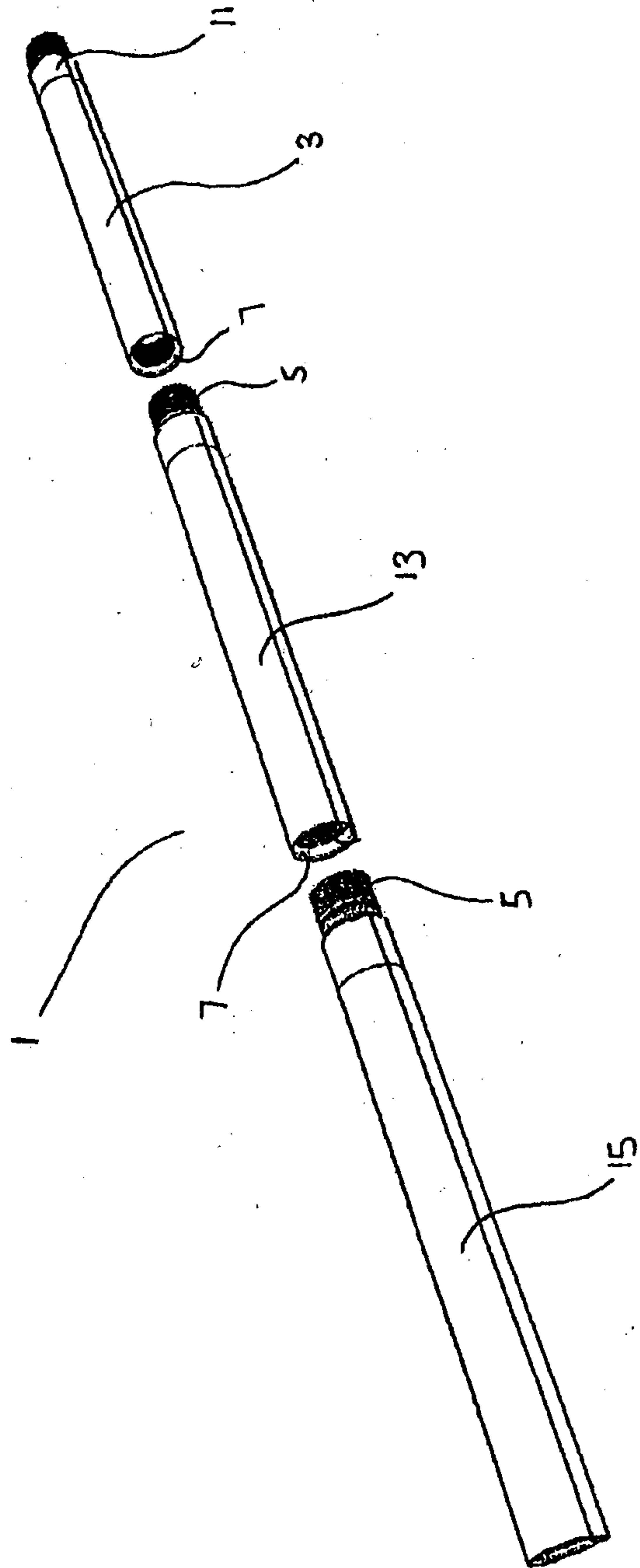


Fig. 1

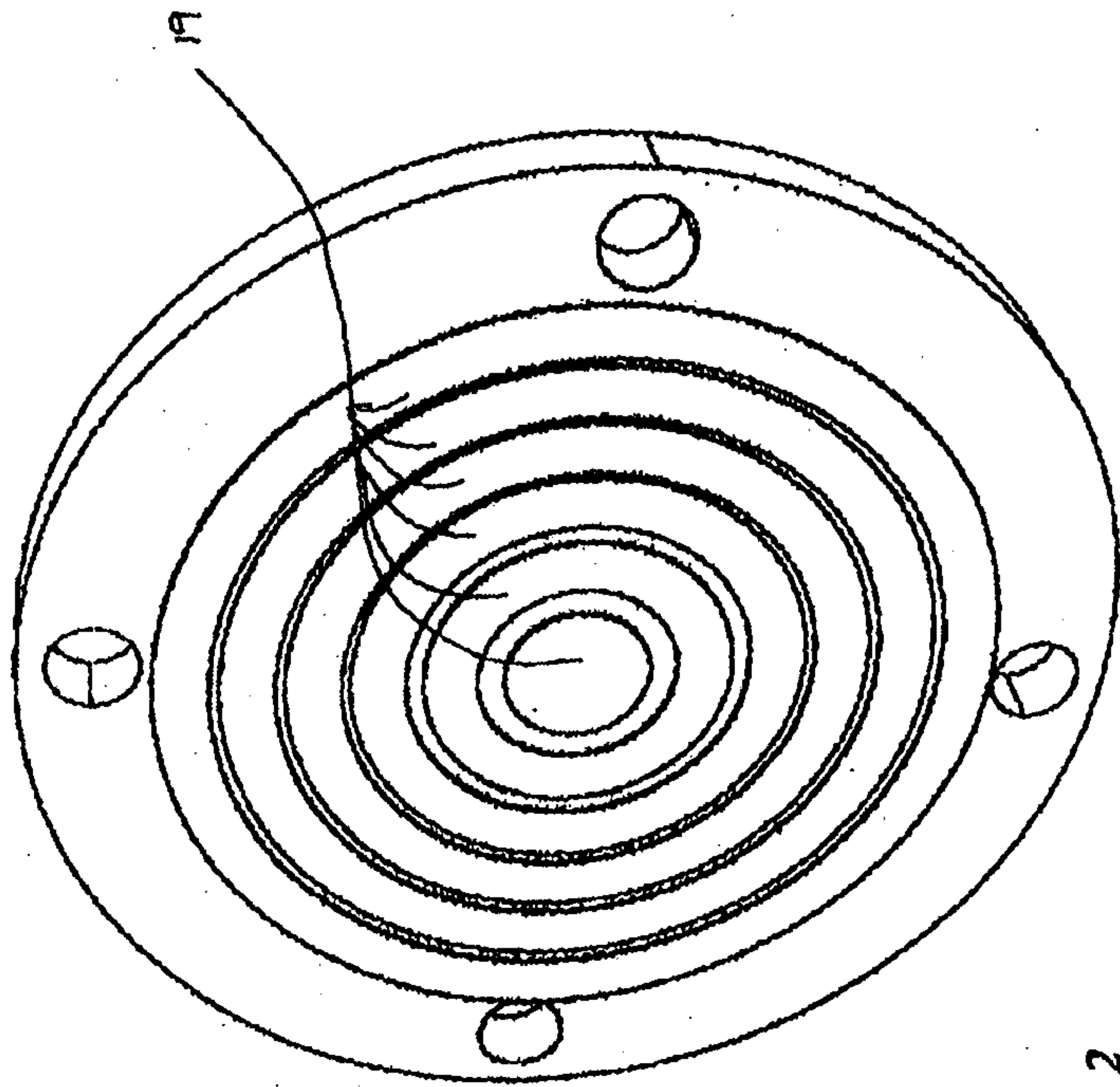
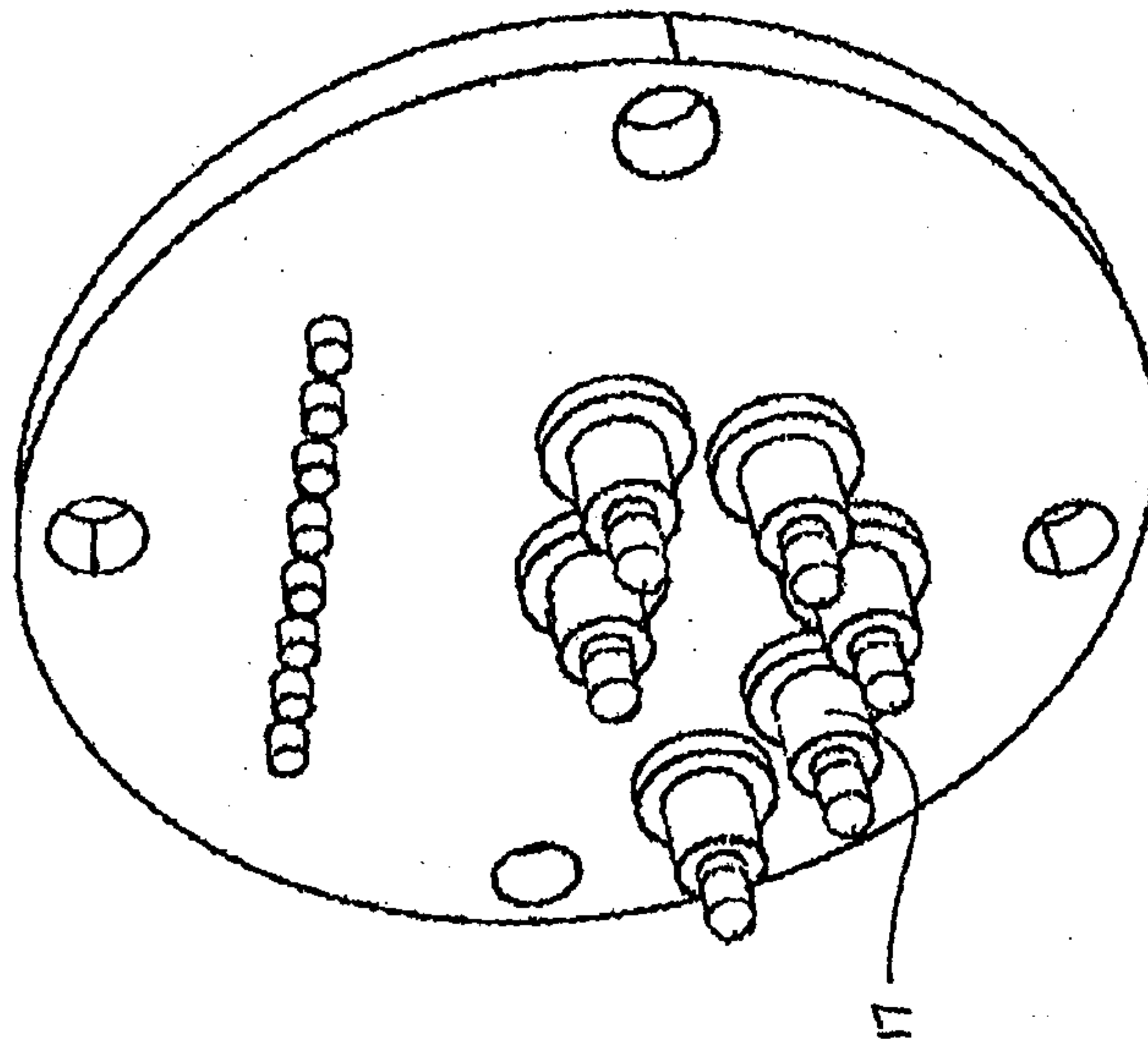


Fig. 2



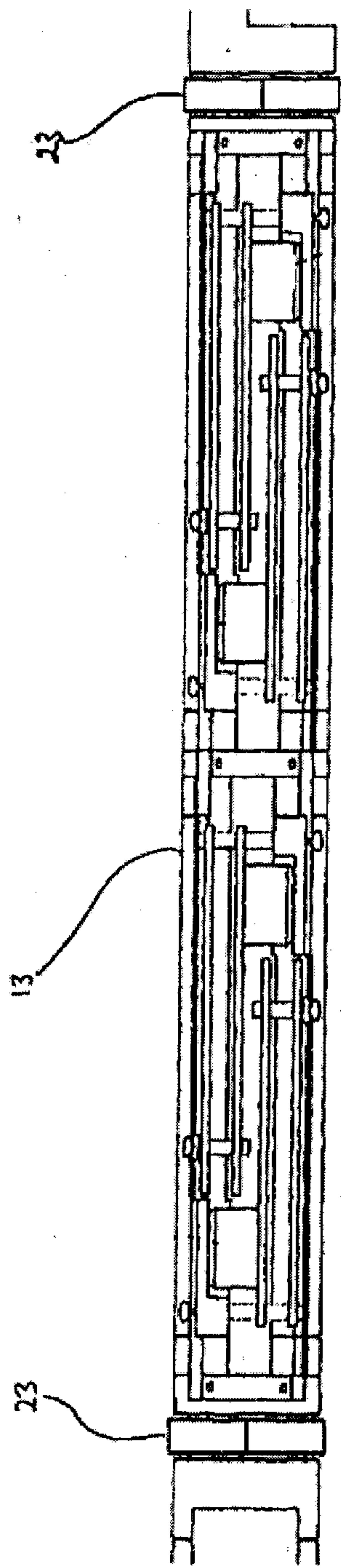
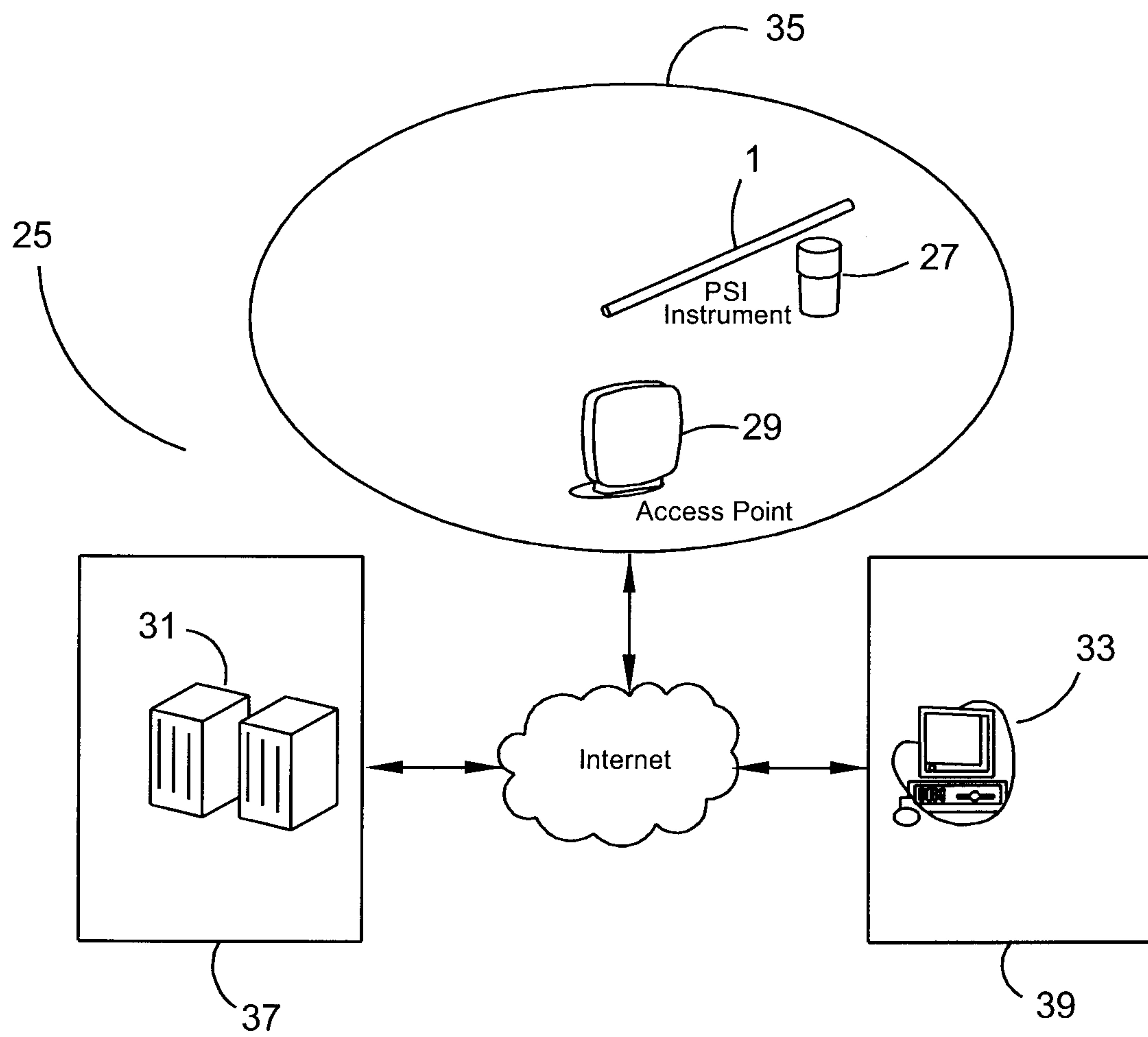


Fig. 3

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**Fig. 4**

