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(54) Title: REHABILITATION DEVICE

(57) Abstract: The invention relates to exercise devices suitable for the rehabilitation, physiotherapy and general exercise. The exercise device may use a capacitance sensor to detect and monitor the position of a user in order to monitor compliance and performance of the exercises. It is envisaged that the data generated from monitoring the exercise can be processed, stored and transmitted remotely to a central station.

REHABILITATION DEVICE

The invention relates to exercise devices suitable for the rehabilitation of patients following traumatic joint or soft tissue injury but also for sports physiotherapy and general exercise. More specifically, the invention relates to an intelligent device that allows a selection of exercise programmes to be monitored.

It is well known that muscles, bones and joints should be exercised to maintain strength. It is also known that fractures exposed to permissible weight bearing stress often heal more predictably and more rapidly than do fractures, which are not stressed at all. This is also believed to be true for connective tissue, such as ligaments and certain cartilage. Similarly the exercising of injured limbs has beneficial effects on the healing of the joint or muscle injury.

Currently the neuromuscular stage of rehabilitation is only addressed by one-to-one therapy treatment, which can be costly and is time consuming. Current treatment systems and devices are concerned with enhancing proprioception via skin receptors or by training balance alone in the therapist's clinic, this could include the wobble board and KAT system.

Previously proprioception was thought of as just balance. However surprisingly the devices of this invention show that the position and angle of the users limbs, and/or the kinesthesia of the users limbs may allow the therapist a better understanding of condition of the limbs of the users. With regard to proprioceptive/neuromuscular rehabilitation this may allow the therapist a better understanding of the progression of a patient's rehabilitation, whether the patient is progressing at the desired rate and whether the exercise programme is suitable to the patient, or if it is not, to change the exercise programme. Similarly this can offer benefits to the therapist working with sports men and women.

Previous physiotherapy equipment and treatment systems needed close supervision by the therapist to ensure that the exercises were being carried out correctly and indeed to ensure that the patient was doing the exercises. The therapist, for the prior art rehabilitation systems had to be

present when the user was being assessed. Usually the user, whether a patient or sports person, would have to travel to the therapist at a clinic to use the equipment, and to perform the exercises. Due to the time wasted between seeing one patient and the next this current system has the disadvantage of being a very ineffective use of the therapist time.

It was previously thought that the current system, of the patient always travelling to the therapist for their rehabilitation treatment could not be improved upon as the treatment system required large, sometimes heavy, expensive equipment which was not easily transportable and that the therapist would have to be present to monitor the exercise programme.

The present invention is able to address these problems of the prior art by assimilating quantitative and qualitative data that can be communicated to the therapist. By interpreting the data the therapist can accurately detect the progress of the patient performing the exercise programme. It was previously thought that the therapist would always have to be present at the time of the exercises as any data collected from the exercises could not interpreted to indicate the progress of the patient performing the exercise programme. Surprisingly we have found that this is not true.

It is an object of the present invention to address some of these before mentioned problems.

It is an object of the present invention to provide a proprioceptive and/or neuromuscular device that will monitor and record the user's performance.

It is an object of the present invention to provide a proprioceptive and/or neuromuscular device, which is portable.

According to the present invention there is provided an exercise device comprising; a lamina with a sensor for sensing contact, and/or position on, or adjacent the lamina; and a processor for processing outputs from the contact, and/or position sensor.

It is envisaged that with embodiments where a position sensor is used, the position sensor will be able to sense where an object is adjacent to the lamina, even if not in contact with the lamina. The term position sensor is to mean any device which can detect contact with the device by any object or can detect the close or near positioning of an object to the device.

With embodiments of the invention that use a contact sensor, it is preferred that the contact sensor can also measure pressure or the force exerted on the lamina.

The term lamina is to include any substantially flat surface suitable to act as a target for an object moved by a user. This will include but not be limited to mats, rugs and the like but will also include sockets pegboards, stacking cones or the like.

In fact the lamina can take any shape where a first object is moved in relation to a second object to be in contact with or adjacent to the second object. This may be where a user moves items from one place to another or placing items into certain cavities.

Embodiments of the present invention may include exercise products such as pegboards and stacking cone pattern boards. A sensor element or lamina can be placed on one or both of the cavity/peg and the object to placed in/over the peg. The sensor element, or lamina, could be a simple electrical contact, or pressure sensor to detect contact of one object against another. However by using a sensor such as a capacitance sensor, the presence of an object merely adjacent to, and not touching, the sensor can be detected.

Preferably when a capacitance sensor is used the object to be detected will be a conducting object, for example such as a metal pole, or peg.

Suitably the device of the present invention whether it comprises a contact sensor, a position sensor or both may also comprise a memory

database to store the processed data generated so that this data can be downloaded or examined by the user or therapist at a later time. The data can be used to assess how well the user is performing the exercises.

Some embodiments of the device of the present invention, whether it comprises a contact sensor, a position sensor or both will also comprise a message conveyor to instruct the user to perform a predetermined exercise programme.

The device of the present invention may therefore comprise of a number of different added components. The present invention in a simple form may comprise of only one sensor, a contact sensor or a position sensor, and a processor. However the present invention may also include devices that have a contact sensor, a position sensor, a pressure sensor, a processor, a memory database and a message conveyor, or any combination thereof.

According to the present invention there is also provided an exercise device having;

a lamina with position/contact sensor which is able to detect contact on the lamina or position of an object adjacent to the lamina;

and a control means connected with the position/contact sensor for receiving outputs from the position/contact sensor,

the control means further including a processor for processing outputs from the position/contact sensor.

In favoured embodiments the processor will have a memory in order to store data generated from the position/contact sensor.

In favoured embodiments of the present invention the position/contact sensor is also able to measure the amount of pressure or force applied to the lamina. In some favoured embodiments of the present invention this is useful for determining the centre of gravity of the patient.

According to the present invention there is further provided an exercise device having;

a lamina with position/contact sensor for sensing contact on the lamina and which is able to detect the position of contact on the lamina, and the amount of pressure or force applied to the lamina;

and a control means connected with the position/contact sensor for receiving outputs from the position/contact sensor;

the control means further including a processor for processing outputs from the position/contact sensor and memory means for retaining the processed data outputs from the position/contact sensor.

Some embodiments of the present invention may also have means to instruct a user to perform a predetermined exercise programme.

It is envisaged that the present invention can be small enough to be easily transportable and therefore the exercise routine need not necessarily be performed at the therapist's clinic. The term therapist is used broadly to mean anyone overseeing the exercise programme or the rehabilitation of the user and this would include, but not be limited to, physiotherapists and occupational therapists.

Likewise embodiments of the device may have means to convey instructions for the exercise programme to the user and has means to monitor and record the users performance, it is again not necessary to use the device in the therapists clinic only.

Not being restricted to performing the exercises at the therapist's clinic has many benefits to both the user and the therapist.

The user can save considerable time by not having to visit the therapist as often and can more easily fit the required exercise programme into his or her daily routine. Being able to do the required exercises in private may also be a favourable consideration to some users and thus the user's compliance for doing the exercises may in fact increase when not in the presence of the therapist. This may be especially true when the device is for rehabilitation of elderly patients.

The therapist also saves considerable time, as data from the device can be collated some time after the exercises have been done and can be

sent to the therapist for analysing or can be down loaded to a data collecting station at a mutually convenient time. The therapist will however still be able to monitor closely the user's compliance of carrying out the exercise and to determine if the exercises are having the desired effect. The monitoring however can be done remotely and does not require the therapist to be present when the exercises are being performed. The therapist can alter the predetermined exercise programme of the device in order to ensure that the user does have an exercise programme suitable to their particular needs. Again this can be done remotely.

As individuals will perform the same exercise programme in very different ways with differing degrees of abilities, especially regarding speed, force and accuracy, it is hard for a therapist to compare the progress of one user with another. For example a young sportsperson may well be able to perform a programme of exercises faster than an elderly person that has been on the same programme of exercises for a longer period of time than the sports person. Consequently for the therapist to measure the progress of the user it is not only how well the user performs the exercise on that particular occasion, but how much of an improvement there is in performing the exercises from before. The present invention provides an easy means to store and analyse the user's current and past exercise data to aid the therapist to monitor the progress of the user and therefore to be able to change the exercise programme accordingly. There is therefore an opportunity for the user to have a speedier recovery, saving time and money for both the user and the therapist.

There is an increasing demand for quantitive (i.e. numerical) records of patients' rehabilitation to be available for the following purposes:

To make therapists accountable for their actions, for instance, for performance reviews or litigation cases.

For feedback to the surgeon/physician, for example for justification for or against further intervention.

For feedback for reimburser, for example to fulfil requirements by insurance companies requiring proof that patients are complying with treatment.

For greater understanding of therapy and clinical research, i.e. optimisation, of treatments and presentation/publication of results.

For standardisation of treatment and common practices.

For overcoming prejudice views of therapists relating to rehabilitation.

The level of feedback to the therapist is determined by how the information will be used. Firstly, the data must be a substitute for clinical observations, which would normally be made by the therapist. The therapist must therefore have sufficient depth of information to allow clinical judgements to be made, and to progress the rehabilitation programme. For example, it is necessary for the therapist to know if the patient can bear weight through an operated knee. It is proposed that data supplied to the therapist will act not only as substitute clinical observations, but will also be capable of providing accurate measurements of how much weight is transferred through the knee, for what duration of time, over what range of motion and for how many repetitions of a specific movement/ exercise. An indication of proprioceptive integrity will also be given by the number of errors in performing a defined task. This data will be available as raw numerical records, but may also be presented in a more accessible way, for example as a bar chart, histogram, graph or percentages. These presentation styles should be available to the user through a menu.

Examples of the information that could be available to the therapist (and/or user/patient) and the appropriate level at which it could be expressed are as follows:

Numeric values

Incidences - the number of times the device was used, repetitions of an exercise/movement, touchdowns during a single leg stance, steps taken (in a weight bearing exercise), movement limitation alerts.

Weight /force - weight/force transferred through a force plate sensor, standing or sitting.

Percentages

Numerical percentage - range of motion of a joint; performance of a repeated task.

Pie chart – Classification of different movements.

Graph - Speed of movement of a limb, i.e. response times

Bar chart /histogram - Performance during a hopping exercise; response times

Stick figure diagram - To clarify the activity being carried out.

The lamina e.g. mat can be positioned to be suitable to detect contact with various objects. Preferably it is envisaged that the user will have an exercise programme that requires the user to move an object either by, for example, hand or foot, to a desired position on the lamina. These programmes may specify whether it is the left or right, hand or foot that moves a particular object. For exercises requiring the user to move his foot or feet to move objects to a desired positions on the lamina e.g. mat, the mat may preferably be positioned on the floor. Likewise for exercises designed to exercise mainly the lower body of the user, the lamina e.g. mat may be preferably placed on the floor. Where the exercises require the user to move objects by hand to various target positions, the lamina e.g. mat may suitably be placed on a table or on a wall or other vertical surface to allow easy positioning of the object to be moved by the user's hand to the lamina e.g. mat. Likewise for exercise programmes that are designed to exercise mainly the upper body of the user, the lamina e.g. mat may also be suitably placed on a table or held vertically. Suitable means of attaching the lamina e.g. mat to a wall or vertical surface could be used to position the lamina e.g. mat. The lamina e.g. mat need not be restricted to substantially flat surfaces for it is envisaged that the lamina e.g. mat could be used on uneven surfaces in order to test a user's balance and/or movement on an uneven surface. Typically the lamina e.g. mat could be used on stairs or on a wobble board. This is especially important for rehabilitation exercises where a

patient may feel quite stable when on surfaces that are substantially even but not when on stairs or when on surfaces that are uneven. Suitable attachment means to attach the lamina e.g. mat, securely to the stairs would be preferably used in conjunction with the mat in order to ensure safe usage of the mat by the user.

The lamina of the present invention may also be part of a movable object e.g. a wobble board, a Continuous Passive Motion (CPM) machine or other exercise machines. The present invention when part of a movable object such as a CPM machine can monitor if a motor is still running or that a patient is still present within the CPM machine. A sensor such as a thin film capacitance element can reliably detect patient presence and could be linked to a timer to determine when the device is being used.

The lamina e.g. mat may also have different textured surfaces for the user to perform the exercises on. This may be where there are different textured surfaces for different exercise programmes or where the lamina e.g. mat is made up of different textured surfaces the same exercise programme.

Likewise the lamina e.g. mat may also be used on soft surfaces. For example the lamina e.g. mat may be used on an exercise bouncer.

The lamina e.g. mat may be of any size or shape, however it is envisaged that when the lamina is a mat, the mat is approximately 1m to 2 m by 1m to 2m in order to allow for easy transportation of the device. It is envisaged that a smaller mat could be used for upper body exercises, for instance 1m by 1m, and a larger mat, for instance 3m by 3m, for exercises directed at mainly the lower body. Typically the mat would be 1m by 2m for exercises directed mainly for the upper body, and typically 2.5m by 1.5m for exercises directed mainly for the lower body. The particular mat need not be limited for any particular programme of exercise and it is envisaged that the one mat could be used for exercises directed at both, the upper and lower, body of the user. When not being used, the mat in some embodiments of the present invention may be easily rolled or folded to facilitate storage.

The mat of the present invention may be formed from a number of parts, which together make up the device. In particular the number of contact, position and/or pressure sensors may change and there is not necessarily a set number of such sensors required. Suitably in preferred embodiments where the device of the invention is assembled from parts it is envisaged that the parts, for example the sensors, will join together easily and quickly to aid easy setting up of the device. In this way the number of sensors used for the exercise programme can be easily altered. In particular embodiments of the present invention the parts of the device may communicate with each other by radio means and therefore the parts making up the invention need not physically be in connected with each other.

The mat can be made of any suitable material including materials from ElectroTextiles UK e.g. ElekTex™. Typically the lamina, e.g. mat, will be an elastic material or fabric. The mat may be a 3D fabric whereby the position/contact sensor contain two rows of metallic strips that run perpendicular to each other and when pressure is applied to the mat the two rows of metallic strips come into contact with each other at the point of the applied pressure thereby indicating where the pressure on the mat has taken place.

Another embodiment of the present invention may contain a mat having a series of individual air pockets, which are the targets for the user to hit. On applying pressure to the air pocket, air is pushed through a valve whereby the control means of the device can record which air pocket was hit and when.

Although such resistance type contact sensing means are cheap and readily available, these types of contact sensing means do suffer from the disadvantage that they contain moving parts which will wear out and not be robust.

Suitably the lamina e.g. mat of the present invention would use a position sensor using capacitance to detect position of an adjacent object. A capacitance sensing mat uses a single plate and senses the presence

of the object. The device has no moving parts and hence is may be very robust. Also with no moving parts the sensing element can be very flexible. The electronics detect a change in capacitance at the isolated pad, which can be any shape or size. Separate circuitry can be used for each pad although if a number of pads are to be used it is possible to multiplex the signals from the pads. The capacitance mat may be supplied with all its pads in place together or may be supplied in parts so that a number of different pads could be used and that the pads can be assembled together to form mats of different shapes.

The sensing pads of the capacitance sensing mat may each have an identifying electrical component such that the processor can identify each pad being used to make up the mat. Therefore when the pads are put together in the correct predetermined order the correct data processing can take place. The pads do not however need to be in contact with each other or even adjacent to each other. The pads only require to be in communication with each other or a central control unit. In this way the processor can identify if the exercise was performed correctly or not.

It may be a requirement that for the desired programme of exercises to be performed correctly that the pads are put together in particular manner to form a mat of a particular shape. Such instructions would have to be conveyed to the user or therapist before performing the exercise. The sensor that make up the lamina may communicate with each other and the processor by radio means such that the sensors do not have to be physically connected to each other or to the sensor, by cables, wires and the like.

Using capacitance sensors in this way, as for large foot size pads, is new, previously only very small capacitance sensors have been used and it was previously thought that the capacitance sensors had to be small due to the possibility of electronic interference. The present invention has now demonstrated that large capacitance sensors can be used to detect accurately contact or position without electronic interference. The present invention has also found that the use of screens around the sensor plate further reduces electronic interference, enabling the capacitance sensors

to be successfully used as large contact sensors for the performing exercises.

Capacitance sensors can be simply used to detect presence of the user, or parts/limbs of the user. The capacitance sensors can be part of devices of embodiments of he present invention to detect presence of the user, parts/limbs of the user or objects moved by the user. Capacitance sensors suitable for use of the present invention having no moving parts as mentioned above are less prone to wear and tear.

The mat of the present invention may also measure the amount of pressure applied to various points of the lamina, not just if contact is made. This may provide useful information to the therapist in order for the therapist to assess if the exercise programme is, among other things, helping the user.

The means to measure the pressure applied to the lamina may be any means suitable for such purpose and there are currently a number of different methods known for measuring pressure and force. In the majority of cases a force reading is taken over a given cross-sectional area and hence is recording a pressure.

The measurement of pressure in a clinical environment is normally required in order to determine the load bearing of the patient's limb or joint.

One suitable means may be where the mat has a flexible fluid chamber, suitably shaped to cover the area of the mat and having first and second opposed walls. The flexible fluid chamber would be without continuous internal elements that would hold the first and second walls apart, but would possibly be subdivided into smaller fluid filled chambers. The chamber would also have means for providing a fluid communication between said chamber and a pressure, sensing device. When pressure is exerted on the chamber, for instance, when an object is forced against the lamina the fluid in the chamber would be forced towards the pressure sensitive device, which would be able to measure the force and this force could be calibrated to measure the force on the lamina.

An alternative method is to incorporate a force/pressure sensing mechanism within the contact, sensing lamina. The force sensing means can take the form of a force, sensing resistor (FSR) as supplied by Steadlands International Marketing Ltd., Northumberland, UK. The FSR consists of two polymer sheets laminated together. One sheet is coated with interdigitating electrodes top a greater or lesser degree. By measuring the resistance the force can be recorded. The sensor takes measurements in the first 20 seconds of loading and then an average of these readings is taken.

Another alternative of the present invention is simply to have a number of hooks where the device of the present invention can detect if an object is hooked to the hooks of the device.

One option for a single, one-off measurement is to use a pressure-indicating film, as supplied by Fuji (Pressure (R)). The film records the pressure distribution according to colours; the more intense the colour, the greater the pressure. The films are single use and would be mounted on the reverse side of the lamina. A colour scale would be provided to the clinician.

Preferably the lamina will have markings to act as specific targets for the user to move the object to make contact with the lamina when directed to do so for the particular exercise programme. This could be simply a series of labelled or indexed grids on the lamina. The grids on the lamina could be of different sizes and therefore suitable for a wider range of exercise programmes. Typically when different size grids are used on the one lamina the grids will be coloured coded in order to allow easy visual differentiation between the grids. Typically the grid spacing will enable desired targets to be large enough for the object to be moved to be placed substantially over the target area.

Other markings could simply be shapes, numbers, letters or pictures on the surface of the mat.

With some embodiments of the present invention the contact/position sensor lamina may not necessarily have the marking directly on the lamina but the lamina could be used in conjunction with a target cover that is to be placed over the contact/position sensor lamina. The target cover may be like a sheath to cover all or part of the lamina and it is the target cover that has the markings to act as targets for the objects to be moved by the user.

Typically the grid spacing will enable desired target areas to be large enough for the objects to be moved, to be placed substantially over the target area.

The lamina may even contain lights on the surface of the lamina in embodiments of the present invention where the lights themselves are the targets for which the user should place the object on, or adjacent to, when that particular light lights up. The lights would suitably be protected from the physical contact of the user putting pressure on the surface of the mat.

Typically the control means will be able to collect and store the data in order to be able to later download the collected data. The downloading of the collected data may be done by the therapist, either at the clinic or elsewhere or the data could be downloaded by the user and sent to the therapist for analysing. It is possible, using suitable means that the collected data could be sent to the therapist by telephone, e.g. e-mail, or radio. It is even possible that the collected data could be sent to a collecting station near to the therapist or at the clinic to enable the therapist to analyse the data when required.

The predetermined exercise programme of the device may be pre-programmed into the device by the therapist. There is no limitation to what exercise programmes could be programmed into the device, in order for the user to carry out the exercise programme. The therapist would preferably choose an exercise programme that would be challenging to the user but still within their capabilities. The exercise programmes may consist entirely of simple commands.

The instructions or commands of what movement the user is required to do can be conveyed to the user by any suitable means. The means to convey instructions or commands to the user need not necessarily be attached to the control unit as the means to convey instructions or commands to the user may be in wireless communication with it. This may be by instructions on a TV or LCD screen that the user can look at whilst performing the exercise programme. The display on the screen may be by any suitable means but would typically be written instructions or a graphic display of what the instructions are. The instructions may also be conveyed to the user by other visual means for example when lights are used within the mat to move to the light, which is switched on or off as the case may be. Additionally the device may incorporate a light projecting means on to the mat where the user must move to where the light projection falls onto the mat. The instructions however could be by simple audio means i.e. audio- tape or digitised voice. In the simplest of embodiments of the present invention the instructions to the user in order to perform the exercise programme may be written on a sheet of paper. Once the device has indicated to the user to start the exercises, for instance, this may be to show that the control unit is switched on and is ready to monitor and record the exercises. Suitably, the user may perform the exercises as written on the sheet of paper.

Besides instructing the user to what exercises to do the present invention may have means to inform the user if the exercises was completed correctly or not. Conveying the message or information back to the user may be by any suitable means, for instance, by light or sound.

In order to have the user feedback whether the user was performing the exercises correctly or not, the feedback system may have the following stages:

Start - to indicate correct neutral or starting position before beginning an exercise but also may be to indicate neutral position at the end of an exercise. This should be neutral sound e.g. buzz, or light e.g. white light. This would give the patient confidence that they were beginning the exercise correctly every time. The correct starting position would quickly

become familiar giving a sense of control, self-direction and ownership of their rehabilitation.

Hit/Success - this indicates that the prescribed instruction/exercise has been successfully performed. It should be indicated by a positive sound e.g. bell or green light. This should reinforce the patient's confidence and hopefully provide motivation.

Improvement indicates that the prescribed instruction/exercise has been successfully performed with an improvement on the previous recorded attempt. It could be repeating bell sound or flashing green light. This is designed to motivate the user.

Miss - indicates that the instruction/exercise has not been performed correctly. It could be a negative sound e.g. low pitch buzz, or red light. It should be followed by a restart command and the Start indication of the correct neutral starting position. The purpose of this would be to prevent incorrect movements.

Alert - this would be used for users who are required to learn limitations to their movements. Examples are learning correct posture for back patients, learning correct lifting technique, preventing uneven weight-bearing, avoiding hip dislocation after hip replacement, and avoiding over-extension following Total Knee Replacement (TKR). The purpose would be to indicate to the user that they were approaching their maximum permitted Range of Motion (ROM) and therefore prevent potentially deleterious movements. The indicator could be an amber light, a low level beep or a vibration. This would prevent re-injury, accelerate healing and give the patient a sense of control and confidence.

Performance level - for users who are highly motivated e.g. athletes and sports people, and who are determined to reach a high level of fitness, it is possible the hits, misses and improvements could be indicated as a bar chart or percentage. The number of repetitions of an activity

could, also be displayed by a simple counter. This would provide motivation as well as a sense of control.

As the instructions to the user may also be in the form of lights or sounds, the present invention should be designed so that command signals are not confused with feedback indicators.

In order to reduce the number of visits to the therapist required by a user when the device of the present invention is for home use, the device of the present invention will suitability also have means to convey information regarding the exercises performed by the user to the therapist. In this way the physiotherapist will be able to monitor the progress of the user without needing to actually see the user. It is envisaged that any suitable means to convey this information from the device to the physiotherapist may be used. These means may include a smart card, which would collect the exercise performance data from the device and then this smart card could be taken or sent to the therapist. The device may also have a telephone modem in order to send the data to the therapist's office. This may be at set times picked by the programmed device itself or when requested by the user or therapist.

The device of the present invention could also be used in the therapist's clinic, or in the presence of the therapist, and this may enable the therapist to monitor the user more quickly than in the past or more efficiently than in the past.

The device may already have programmed into it an alerting system which when the exercises have been performed a set number of times, at a set efficiency, the user, or therapist, is alerted to download the information.

In the simplest form, the data may be printed out for sending to the therapist or the device itself may be returned to the therapist.

The invention further provides a method of manufacturing an exercise device comprising the step of connecting;

a lamina having a contact and/or position sensor; with a processor for processing outputs from the contact and/or position sensor.

The invention further provides a method of manufacturing an exercise device comprising the step of connecting;

a lamina with position/contact sensor for sensing contact or position adjacent to the lamina;

and a control means interconnected with the position/contact sensor for receiving outputs from the position/contact sensor;

the control means further includes a processor for processing outputs from the position/contact sensor and memory for retaining the processed data outputs from the position/contact sensor.

Further according to the present invention there is provided a method of manufacture of an exercise device comprising the step of connecting;

a lamina with position/contact sensor for sensing contact on the lamina and which is able to detect the position of contact on the lamina, and which contact sensor is able to detect the amount of pressure or force applied to the lamina;

and a control means interconnected with the contact sensor for receiving outputs from the contact sensor;

the control means further including a processor for processing outputs from the contact sensor; and

further includes a memory for retaining the processed data outputs from the contact sensor.

The invention will now be further described by way of example only with reference to the drawings, which are:

Fig. 1 shows a device according to a first embodiment of the invention.

Fig. 2 shows a mat according to a second embodiment of the invention.

Fig. 3 shows a capacitance sensing mat according to a third embodiment to the invention.

Fig. 4 shows a first layer of a pad of the mat shown in Fig. 3.

Fig. 5 shows a second layer of one pad of the mat shown in Fig. 3, to be positioned under the first layer.

Fig. 6 shows a third layer of one pad of the mat shown in Fig. 3, to be positioned under the second layer.

Fig. 7 shows a fourth layer of one pad of the mat shown in Fig. 3, to be positioned under the third layer.

Fig. 8 shows a top layer of one pad of the mat shown in Fig. 3, to overlay the first layer.

Fig. 9 shows a perspective view of two interlocking portions of a mat according to one embodiment of the invention.

Fig. 10 shows a perspective view of two interlocking portions of a mat according to a further embodiment of the present invention.

Fig. 11 shows a perspective view of two interlocking portions of a mat of a further embodiment of the present invention.

Fig. 12 shows a device according to a further embodiment of the invention.

Fig. 13 shows a cavity of the device of Fig. 12.

Fig. 14 shows a peg of a further embodiment of the invention.

Fig. 1 shows a first embodiment of the invention whereby a lamina (1) is attached to a control unit (2). The control unit (2) is also connected to an audio microprocessor (3) that is able to give audio instructions of the predetermined exercise programme to the user of the device.

Fig. 2 depicts a pressure sensitive mat (21) for use in accordance with a second embodiment of the present invention. The mat (1) has a target grid on its upper surface.

Fig. 3 depicts a pressure sensitive mat (4) for use in accordance with the present invention whereby the pressure sensitive mat (4) is a capacitance sensing mat. A sensor (not shown), for each grid space, positioned near the top surface of the mat can measure the capacitance between the object moved by the user near to, or on, the grid space and an earth screen positioned on the other side of the sensor from the object moved.

It is envisaged for simplicity that the capacitance sensing mat need only measure a change in capacitance to enable detection if the object is present at a particular grid or not. It is however possible that the capacitance sensing may be more sophisticated and could measure actual capacitance values. The capacitance values can be used to indicate how close the object is to the capacitance sensing mat.

Figs. 4 to 8 show various layers of one grid portion of the mat according to the mat shown in Fig. 3, and are described further in the Examples hereinafter.

The two interlocking portions of the mat shown in Fig. 9 interlock via a tongue and groove joint that is fixed on a cylindrical barrel to allow rotation and movement in the joint to allow ease of connecting the interlocking portions and so that the mat need not be strictly horizontal The internal circuit is connected to a central point on a connector part of the interlocking portion via a flexible conductive strip, which allows movement in the joint without comprising data transmission.

Fig. 10 shows two interlocking portions of a mat of the present invention that lock together by a finger joint mechanism. The conductive element is situated on the outside of one of the finger joints, which may slot into the second portion of one of the joints of a neighbouring interlocking portion. The contact between the interlocking portions may

have two hundred and seventy degrees in coverage it allows complete rotation and movement in the joint, maintaining information transfer between the portions.

Fig. 11 shows two interlocking portions of a mat according to the present invention that may join together by a snap-fit ball and socket joint. The two portions simply pop together forming a link. The joint is coated with an appropriate conductor over the surface to allow electrical transmission of data and power. As the joint is a ball and socket joint it accommodates any unpredictable movement aiding the transmission of data.

Figs. 12 and 13 show an exercise device having a board (121) with nine cavities (122) or pots sized to fit and hold a metallic cylinder (123).

The inside sides of the nine cavities (122) of the board (11) have a conducting sheet (131) embedded into the surface of the sides of the cavities (122). This conducting sheet is in communication with a capacitance sensing circuit (132) when a metallic object like the metallic cylinder (123) is placed within the cavity (122) capacitanced adjacent to the conducting sheet (131) is detected, thus the presence or absence of the metallic cylinder (123) can be measured.

Fig. 14 shows a peg (141) with a capacitance position detector (142) able to detect a metallic cap (143). An exercise device of the present invention may use a number of such pegs (141) to detect a metallic cap (143) moved by a user during an exercise programme.

Examples of the manufacture and use of the invention are described below:-

Example 1

An exercise device having a 3D pressure sensitive mat with two rows of parallel metallic strips, the strips in each row running substantially perpendicular to each other along the top and bottom surfaces which when pressure is exerted on the mat, contact between the metallic strips

is made indicating to the control unit where on the mat the contact was made. The position and time intervals between contact on the surface of the mat are monitored. The mat is positioned on the floor and the user is instructed audibly from a microprocessor to perform particular exercises by placing a fairly heavy object on various positions on the mat. The grid measures approximately from 1.5m by 1.5m and has two colour-coded grids. A solid line blue coloured grid whereby the grid forms squares with sides of 30cm in length and these squares are evenly divided into four by a red coloured broken line grid (as shown in Fig. 15). The blue coloured grid is labelled in the centre of the squares by blue numbering one to twenty five. The information is collected and stored in the control means. After performance of the exercise programme the data collected is sent by telephone via a modem to a central data collecting station at the therapist's clinic for the therapist to analyse the data at a later time. The therapist can therefore monitor compliance by the patient and the accuracy and speed of carrying out the programmed exercises. In this way the therapist saves considerable time in monitoring the user but can still monitor the benefits of performing the exercises.

Example 2

An exercise device comprising, a rubber pressure sensitive mat hanging from a door. The mat is hung from the door by a light plastic clip that attaches to the mat and hangs over the top of the door. The door is closed to hold firmly the mat in a stable position. The position/contact sensor of the mat consists of two rows of parallel metallic strips, the strips in each row running perpendicular to each other. When pressure is applied to the mat the metallic strips running perpendicular to each other make contact and the control unit attached to the pressure sensitive device, is able to collect data concerning when the mat had pressure put on it and at what position on the mat. The mat is approximately 1m by 1m with different coloured circles measuring 15cm in diameter on the outer facing surface of the mat. The position/contact sensor is connected to a control unit, which is itself connected to a coloured TV via the aerial socket of the TV. The TV is placed in view of the user when the user is positioned next to the mat. The control unit conveys instructions to the user via the TV screen as the TV screen displays the particular colour of

the target circle. The user is instructed to raise a stick and make contact with the stick and the target circle, in accordance with the predetermined exercise programme, programmed by the therapist beforehand. The compliance of the user and the accuracy and speed at which the user completed the exercise programme is monitored. This data is collected and stored by the control unit until downloaded by the therapist to a central data collecting station by telephone via a modem.

Example 3

Exercises are executed on a mat consisting of 12 numbered pads arranged in a 4 X 3 (four pads by three pads) arrangement as shown in Fig. 3. Each pad measures 300mm by 300mm and has individual electronics connected to a laptop personal computer (PC) that are able to detect when contact with the individual pads are made.

The patient/therapist interface and data analysis is done by the PC using the software Labview v5.1 or equivalent.

The pads are made up of a number of layers. The first layer (Fig. 4) has a centrally positioned square sensor (5) measuring 170mm x 170mm and a screen (6) 205mm by 205mm surrounding the sensor but not touching it. The screen (6) is connected to the earth screen (7) of the third layer (Fig. 6) and acts to prevent electrical interference from for example other sensors.

The second layer (Fig. 5) has a guard plate (8) the same size as the sensor and positioned directly underneath the sensor.

The third layer (Fig. 6) as mentioned has the Earth Screen (7), which is larger than the sensor (5) and guard plate (8) and measures 205mm by 205mm. This acts to prevent electrical interference with sensor for example from the floor direction.

The fourth layer (Fig. 7) is a backing layer of vinyl floor covering that is 1.5mm thick.

A top layer (Fig. 8) consisting of a calico sheet (a woven cotton fabric) is stuck to the top layer to prevent abrasion of the electrodes and to be a fixture for the target numbers which are fixed to the top layer using iron-on ink jet film.

The above-described layers make up a capacitance contact sensor such that when a metallic object completes the capacitor, and the sensor detects the electrical difference between the guard plate and the body part

of the user. The capacitance sensor can therefore detect the presence or absence of a metallic object on the pad. In sophisticated embodiments of the invention the capacitance sensor will be able to give different reading values of the capacitance detected.

The screen surrounding the sensor acts to protect the sensor against electronic interference or from measuring the capacitance between the guard plate and other objects only near to this particular pad i.e. when the user is standing on an adjacent pad or simply moving over the pad.

The layers are stuck together using an adhesive.

The exercise file or computer programme is a text file and is loaded into the PC, the computer programme of this example is of an exercise programme for moving a light metallic cylinder sized to fit easily on one capacitance pad.

The programme is set to ask the user to move the light metallic cylinder to various pads of the mat.

Example 4

An exercise device (as shown in Figs. 12 and 13) having a board with nine cavities sized to fit and hold a metallic cylinder was used by a user to perform an exercise programme. The ability and time to perform the exercises programme by the user was monitored to, and data was sent via e-mail to a central computer at the therapist's office/clinic to analyse the data in order to assess the user's performance of the exercise programme.

Example 5

An exercise device comprising a pulley system in which capacitance sensors detect the presence or absence of a user and which also comprises capacitance sensors which detect the presence, contact and/or movement of a handle to be moved, or which is movable, by the user.

CLAIMS

1. An exercise device comprising; a lamina with a contact and/or position sensor for sensing contact, and/or position on, or adjacent the lamina, and; a processor for processing outputs from the contact, and/or position sensor.

2. An exercise device as claimed in claim 1 in which the exercise device is a mat.

3. An exercise device as claimed in claim 1 in which the exercise device is a peg board.

4. An exercise device as claimed in any one of claims 1 to 3 in which the sensor is a capacitance sensor.

5. An exercise device as claimed in claim 4 in which the capacitance sensor detects the contact, and/or position of a user directly.

6. An exercise device as claimed in claim 4 in which the capacitance sensor detects a user indirectly, by sensing a movable object in which the object is movable by the user, either movable, directly by the user or indirectly by the user, such that the position of the user, or position of part of the user e.g. a limb, can be detected.

7. An exercise device as claimed in any one of claims 4 to 6 in which the capacitance sensor does not have moving parts.

8. An exercise device as claimed in any one of claims 4 to 6 in which the parts of the capacitance sensor are stationary.

9. An exercise device as claimed in any preceding claim in which the exercise device comprises a memory to store processed data generated.

10. An exercise device as claimed in any preceding claim in which the exercise device comprises a transmitter to transmit data and/or information to a remote source e.g. a data collecting station.

11. An exercise device as claimed in any preceding claim in which the presence of a user is detected, or monitored, when the user is positioned to use the exercise device.

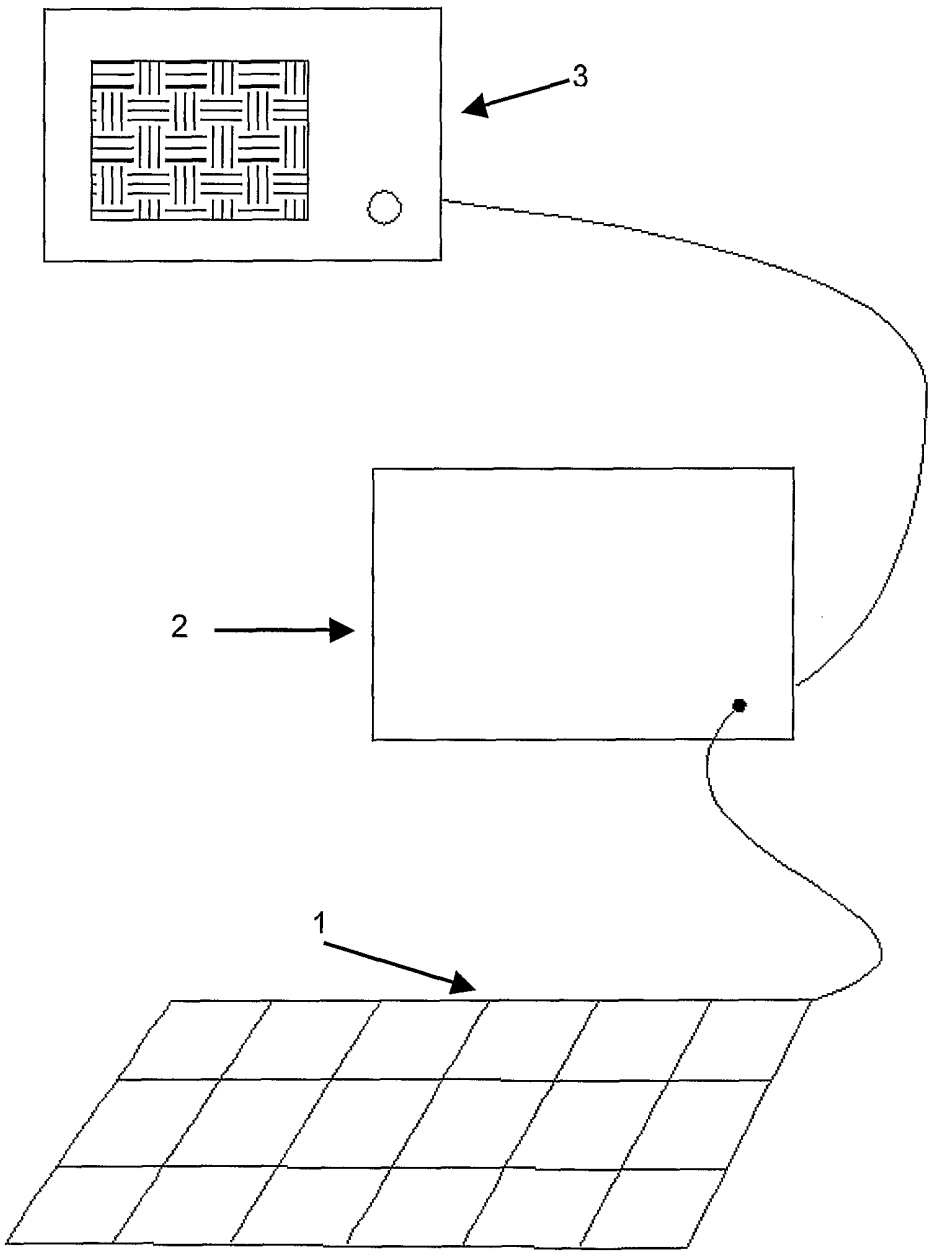

Fig. 1

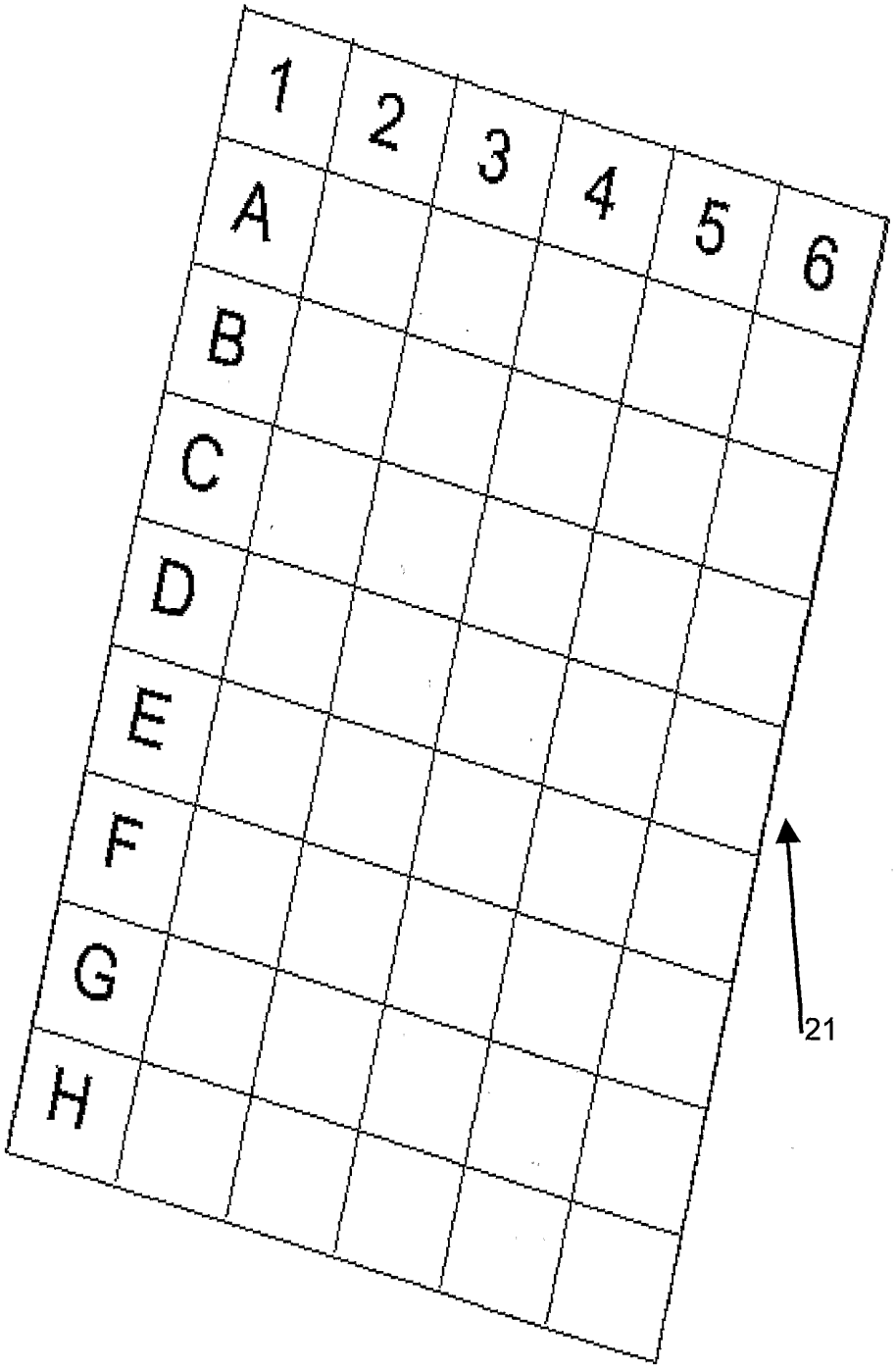

Fig. 2

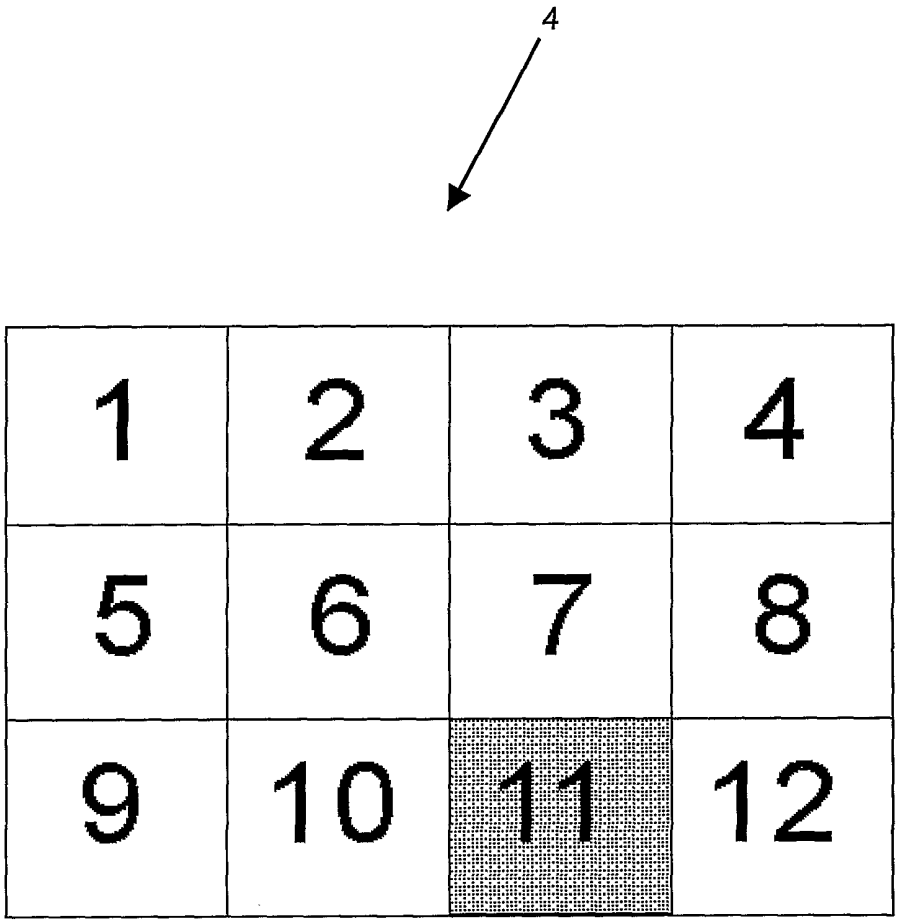

Fig. 3

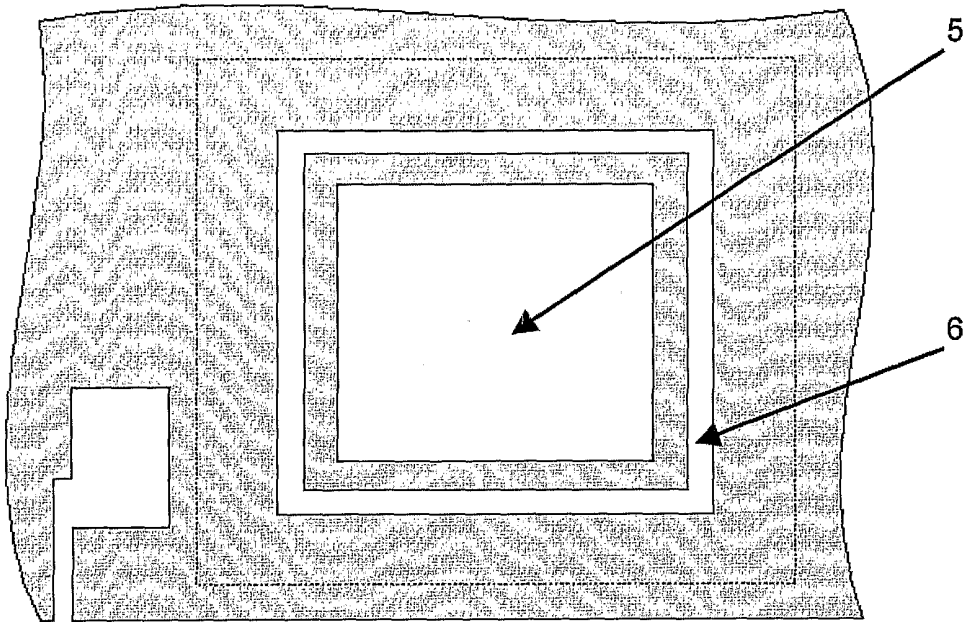

Fig. 4

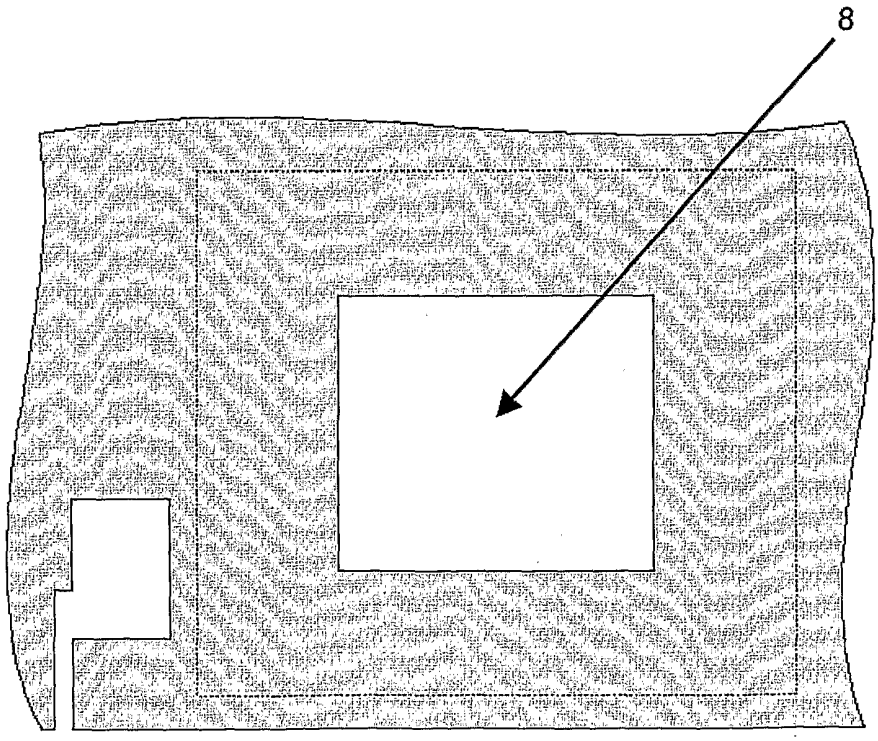

Fig. 5

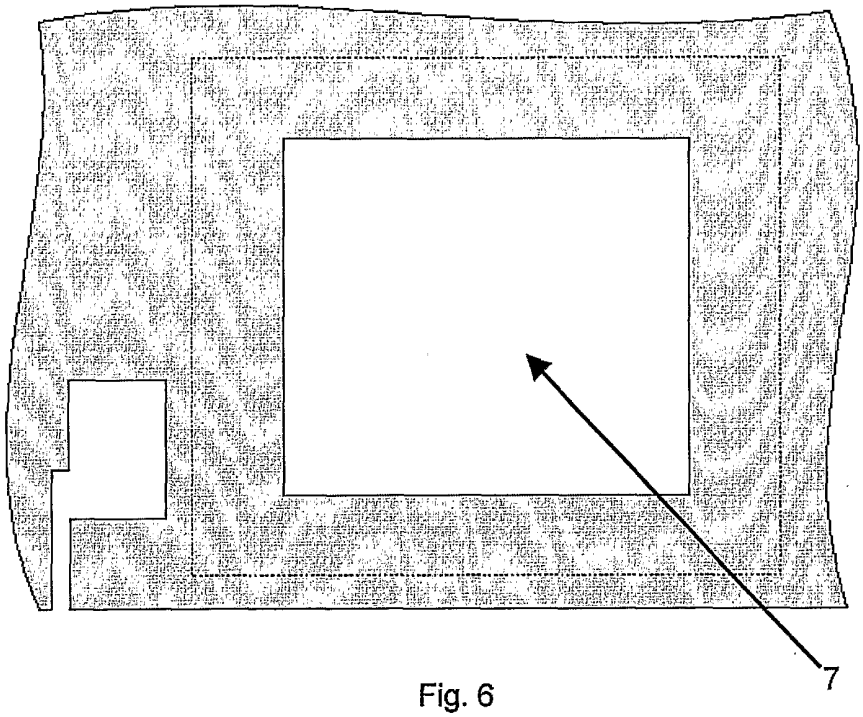

Fig. 6

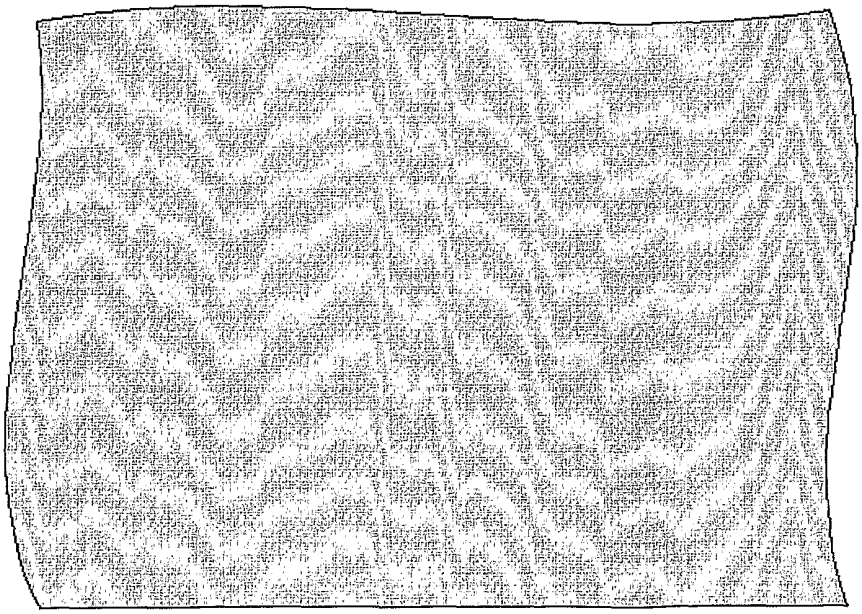

Fig. 7

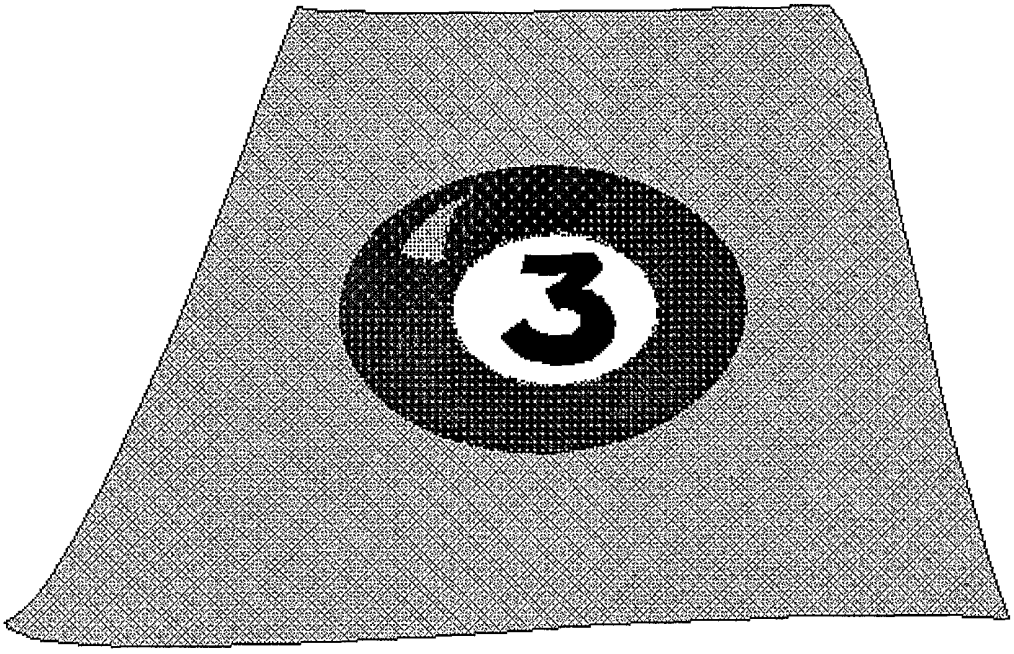

Fig. 8

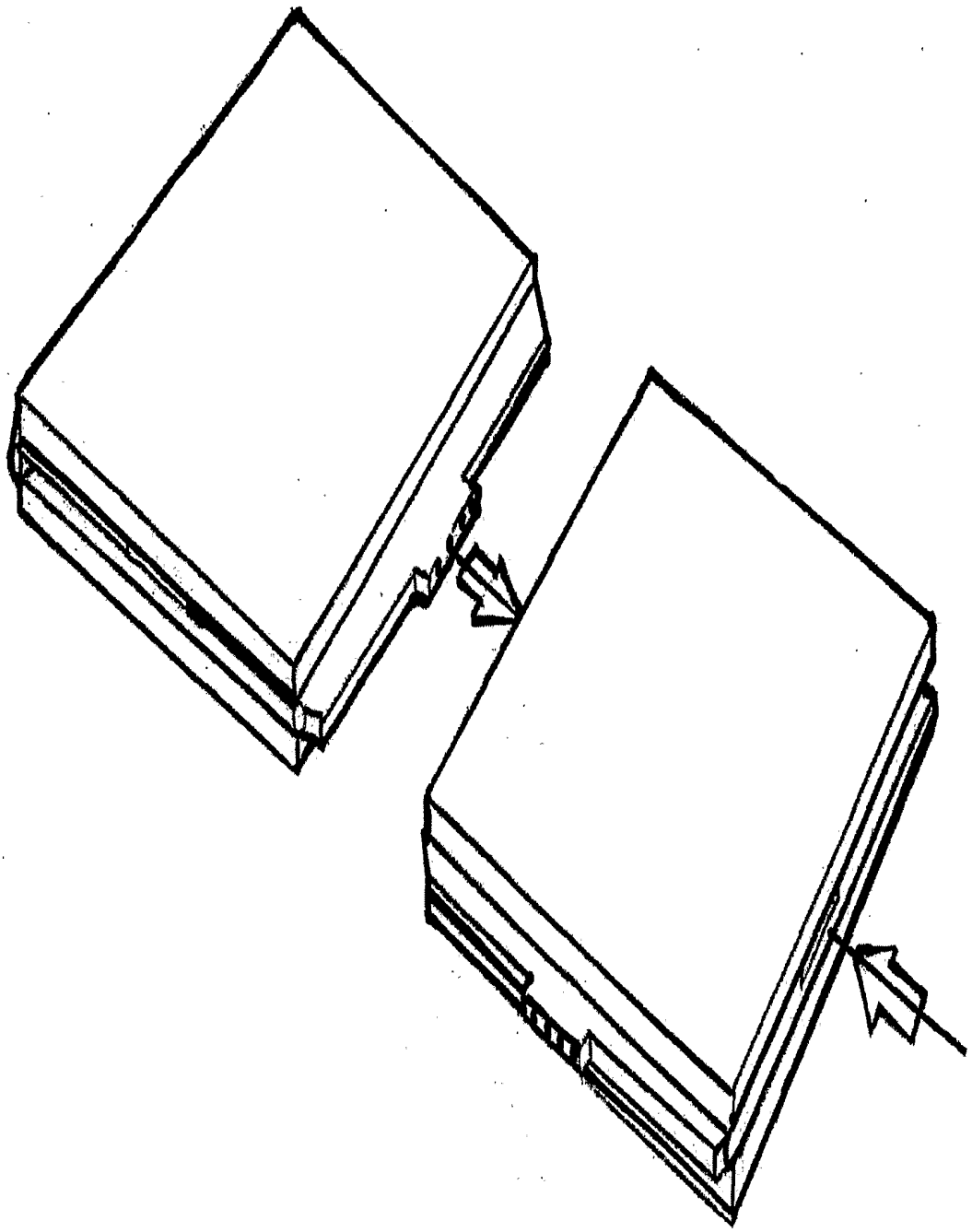

Fig. 9

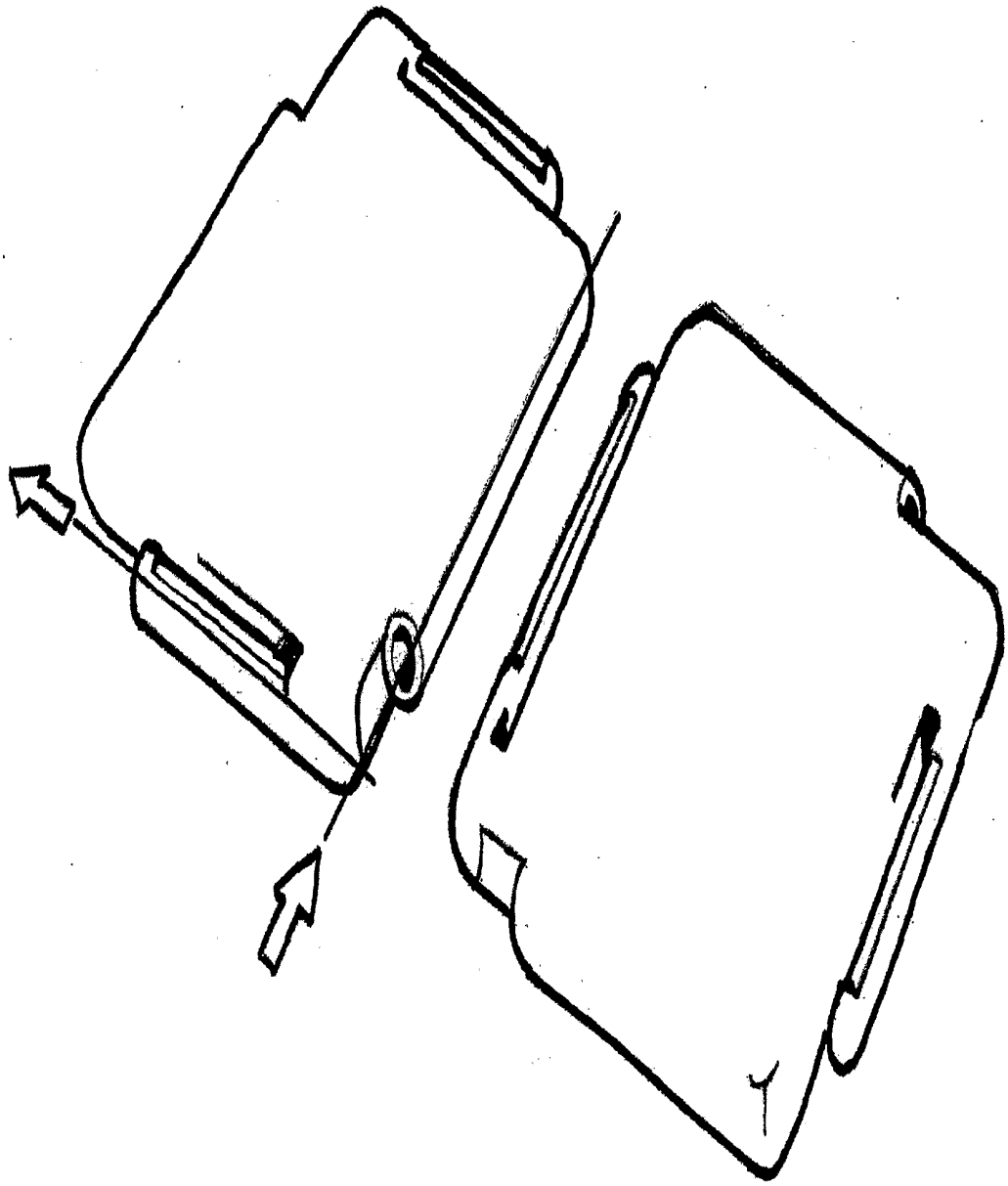

Fig. 10

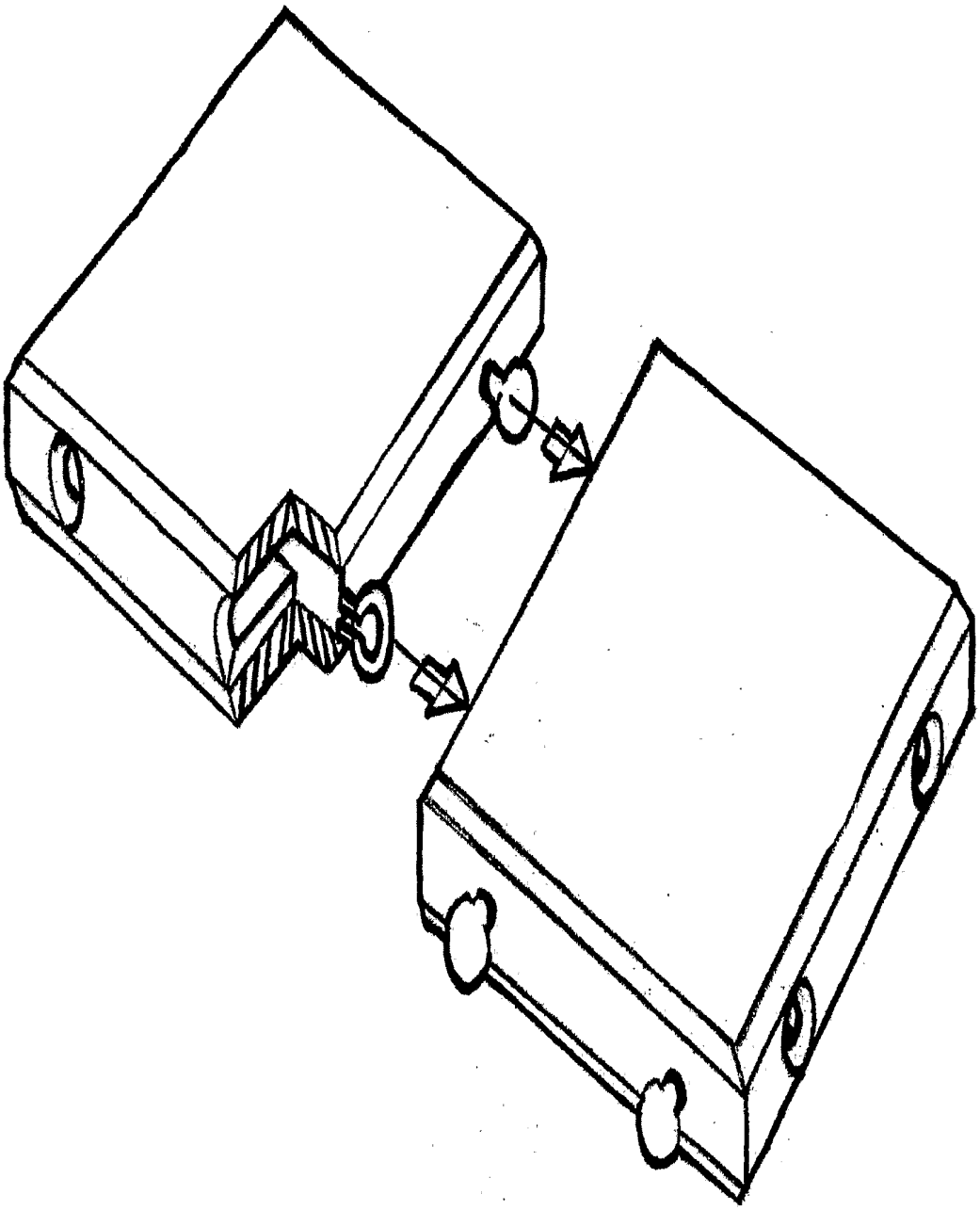

Fig. 11

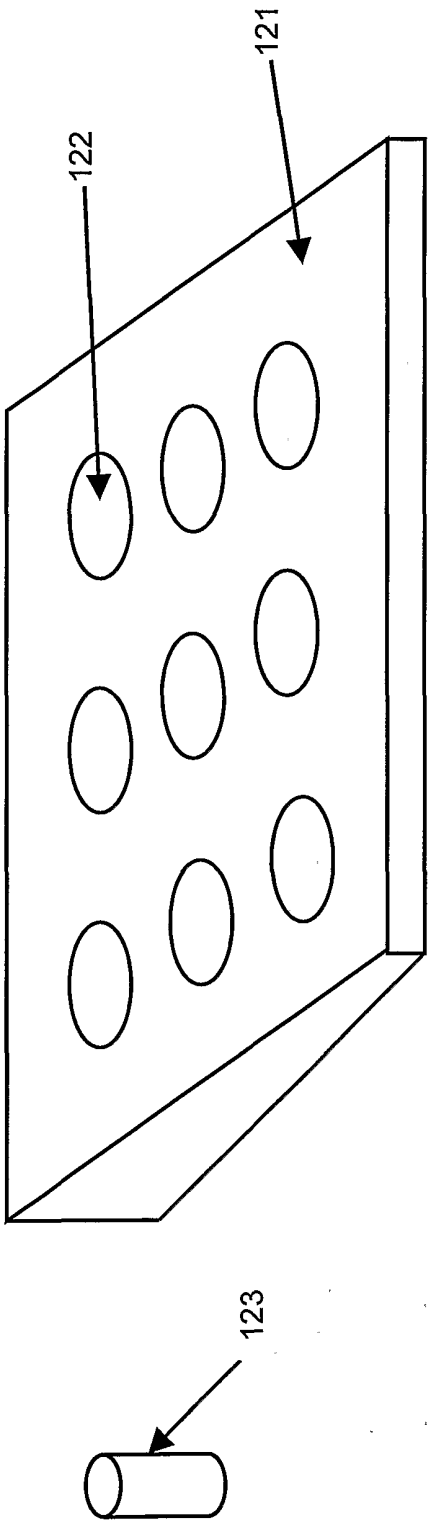

Fig. 12

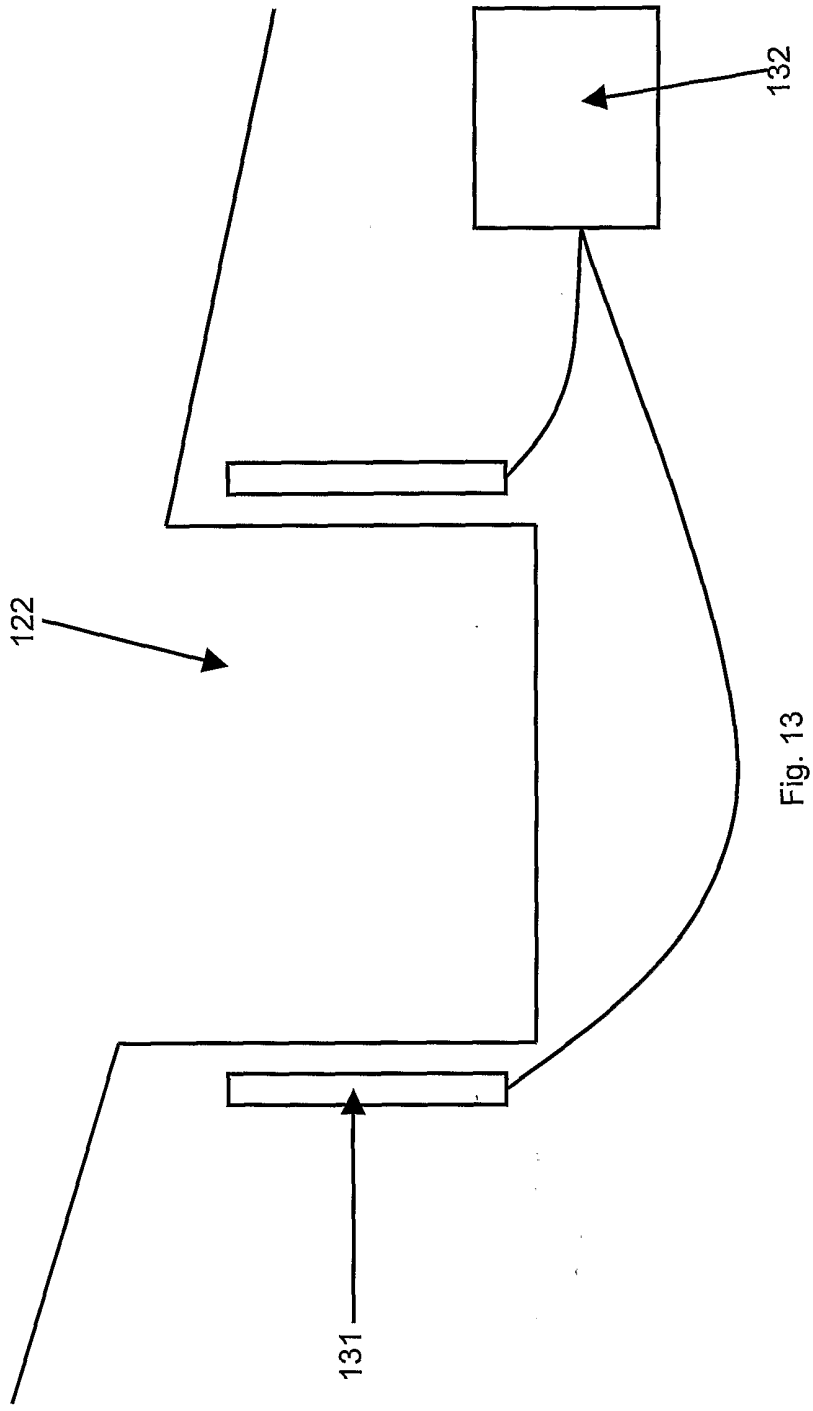

Fig. 13

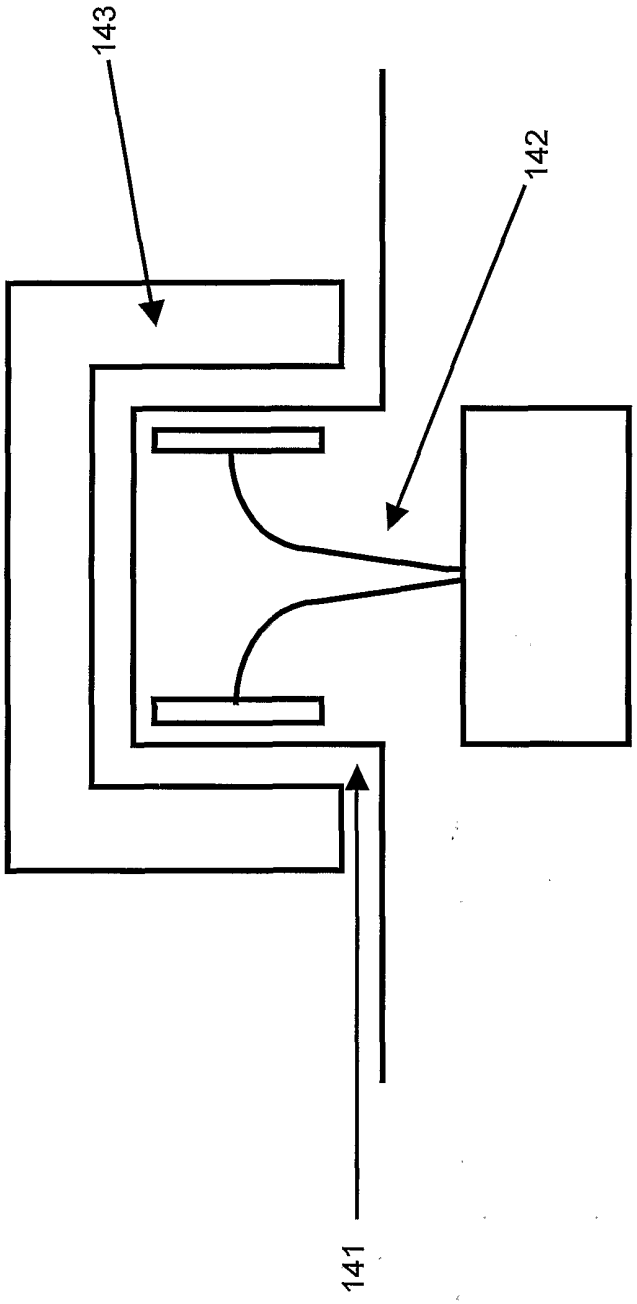

Fig. 14

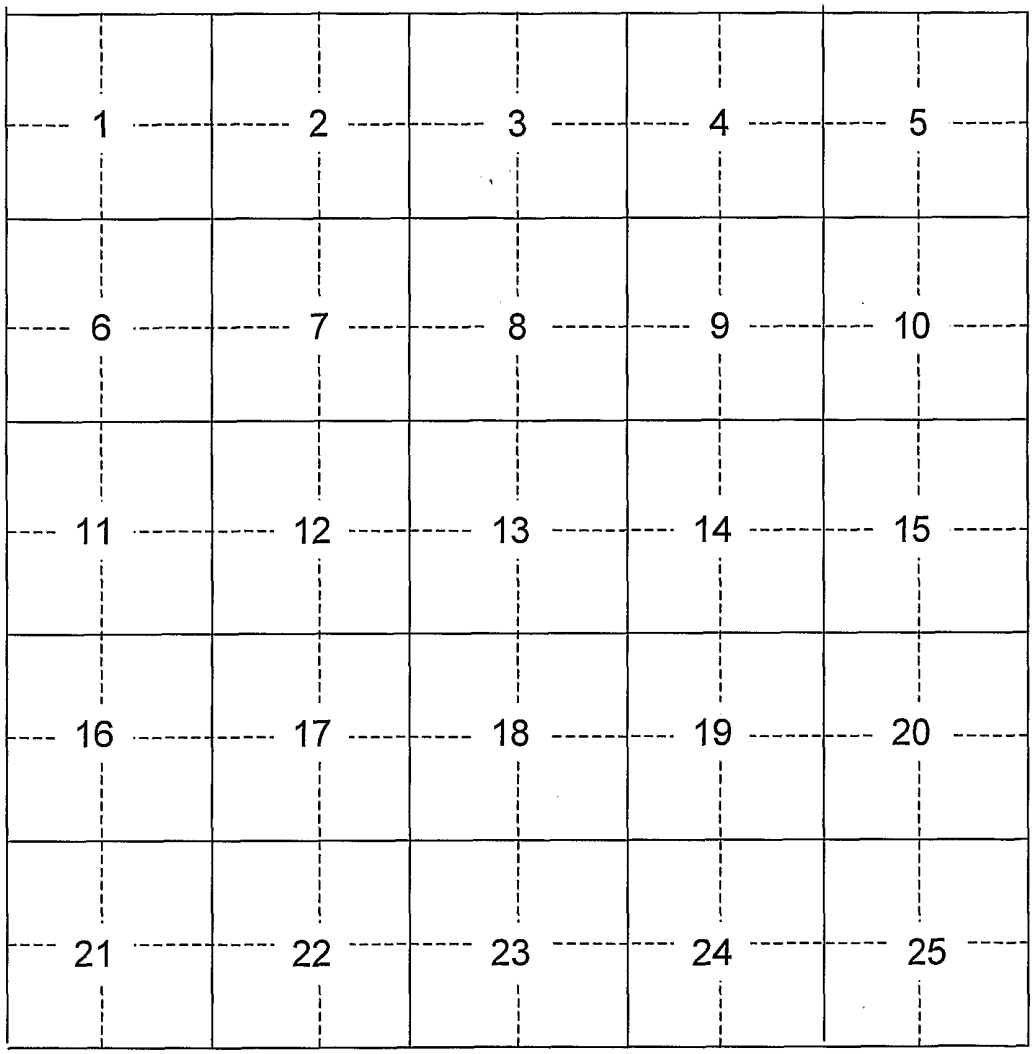

Fig. 15