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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 October 2003 (30.10.2003)

PCT

(10) International Publication Number
WO 03/089069 A1

(51) International Patent Classification[7]: A63B 21/06, 24/00

(21) International Application Number: PCT/AU03/00452

(22) International Filing Date: 17 April 2003 (17.04.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PS1754 17 April 2002 (17.04.2002) AU

(71) Applicant *(for all designated States except US)*: **KINETIC PERFORMANCE TECHNOLOGY PTY LIMITED** [AU/AU]; P.O. Box 179, Jamison Centre, ACT 2614 (AU).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **SHUGG, Rob** [AU/AU]; P. O. Box 179, Jamison Centre, ACT 2614 (AU). **LAWTON, Evan** [AU/AU]; P. O. Box 179, Jamison Centre, ACT 2614 (AU). **RICKETSON, Jonathan** [AU/AU]; P. O. Box 179, Jamison Centre, ACT 2614 (AU).

(74) Agent: **NATH LAWYERS**; 2 Lansell Circuit, Wanniassa, ACT 2903 (AU).

(81) Designated States *(national)*: AU, US.

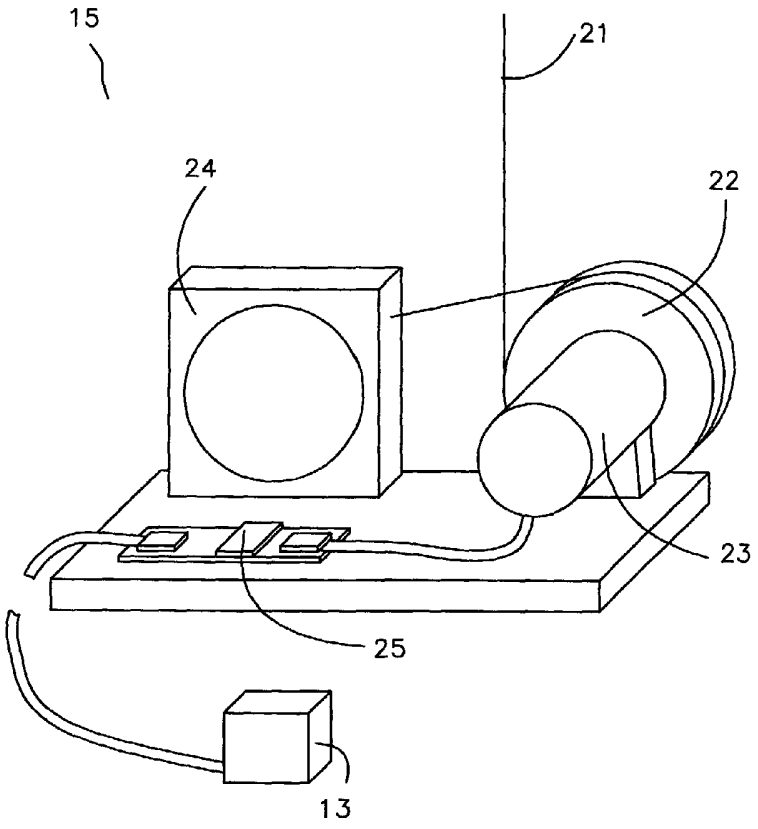
(84) Designated States *(regional)*: European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *with international search report*
— *with amended claims and statement*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS FOR RECORDING, MONITORING AND ANALYSING PERFORMANCE IN THE GYM



(57) Abstract: A system for recording, monitoring and analysing performance in the gym includes a transducer (15) and interface (13) fitted to standard gym equipment (1). Client software for a handheld computer (16), interface software for a personal computer (PC), and server software for a host system. The client software is used to record and send data representing time, displacement and angle of the lifted weight (30). The interface software facilitates transfer of the data from the handheld computer (16) to the host server. The server software facilitates upload of data, which it stores, analyses and reports through a web interface and by file downloads. It also allows for on-line programming of exercise routines for later download into handheld computers, through the PC interface software.

WO 03/089069 A1

METHOD AND APPARATUS FOR RECORDING, MONITORING AND ANALYSING PERFORMANCE IN THE GYM

FIELD OF THE INVENTION

The present invention relates to exercise equipment and physical conditioning in general. In particular, the present invention relates to a system and its methods for automatically recording, monitoring and analysing exercise performance on various types of standard exercise equipment.

BACKGROUND OF THE INVENTION

As a result of increasing concern for physical fitness and performance, the number of people attending gyms, health clubs or fitness centres is growing. While some people limit their training to cardiovascular–type exercises, others have discovered the many benefits of weight training. Weight training in general has been shown to increase lean muscle mass, improve posture, strengthen joints, and raise metabolic rate. It is generally accepted that, to obtain the maximum health benefits, an exercise/training program that includes a combination of cardiovascular and weight training is required.

Within the gym/fitness industry there has been a move towards using electronic based aerobic equipment, such as the stair-climbers, steppers, treadmill, and the stationary rowing and cycling machines. Whilst such exercise equipment provides a certain amount of user performance information, there exists a need to quantitatively monitor weight training sessions.

Gym training - like other sports - could be made more effective by performance monitoring and analysis. It is not enough to just count the number of repetitions of a certain weight, as it does not allow for the quality of the workout to be assessed. There is prior art already providing this limited capability (Wittrock - US Pat No 5,944,633 and Beutel – German Pat. No. DE 3807,038-C). performance monitoring and analysis is about quantifying the demands of exercise in a manner that can provide insight into physiological adaptations and ability to perform.

With high quality performance analysis the physical development of the person could resemble more of a formal education process with regular assignments and assessments much in the way any profession is developed.

A system, which enables this type of formalisation, would be desirable. Many people currently recognise the value of the formal education process in developing a particular skill set rapidly. Such a system may not make users any stronger or faster than they would become normally, but it would aid in getting them there more quickly and aim at keeping them performing at their best longer.

Essential measurement parameters for a full performance assessment are: acceleration of the bar; peak acceleration; path traced by the bar; peak velocity; point of peak velocity; work done; time; and displacement.

A system that works to quantify these parameters by measuring the acceleration of weights, training bars and machines to determine quantitatively the work done in lifting the bar would be useful to many gym users.

The gym and personal training industry is very competitive and growing rapidly. Gym users and clients are becoming more discerning and better educated in their approach to selecting a service provider. These service providers are on the lookout for ways to differentiate from their competitors.

Systems that provide some of this functionality have been developed (Dyer – US Pat. No. 4,828,257) but they have a number of limitations in that they require an expensive purpose built machine which has its own connection to a computer network. A system incorporating a retro-fittable sensor to existing gym equipment which does not require any network cabling has been disclosed (Ben-Yehuda – US Pat. No. 6358188 B1) however it uses an optical system to view and measure the movement of the weights directly. This requires that the weights be modified to interact with the sensor. While this does track the movement of the weights it is complex and requires significant computational power in the sensor and significant modification to the gym equipment to mount the sensor.

SUMMARY OF THE INVENTION

In one aspect, the present invention accordingly provides apparatus for the monitoring of performance in the course of physical exercise using a weight or the like, which apparatus includes:

a flexible cord including an attachment portion that is attachable, directly or indirectly, to the weight or the like;

remote from the attachment portion, retracting means for retracting the cord; and

intermediate the attachment portion and the retracting means, means for generating signals which are indicative of at least one of:

the longitudinal movement of the cord away from and towards the retracting means consequent on movement of the weight or the like, and

the extent of angular movement of the longitudinal line of the cord consequent on movement of the weight or the like.

In another aspect, the present invention provides apparatus for the monitoring of performance in the course of physical exercise by moving a weight against gravity, the apparatus including:

a weight mounted for vertical movement both with and against the force of gravity;

a flexible cord attached to the weight to move the weight by human exertion against the force of gravity; and

means for monitoring the longitudinal movement of the flexible cord in the course of the movement of the weight.

In yet another aspect, the present invention provides a method of monitoring performance in the course of physical exercise using a weight, which method includes the steps of:

attaching one end of a a flexible cord to the weight;

anchoring the other end of the flexible cord at an anchor so that the length of the cord is:

retractable towards and away from the anchor; and

maintained in a taut line as it retracts towards and away from the anchor, and

generating signals which are indicative of at least one of:

longitudinal movement of the cord away from and towards the anchor consequent on movement of the weight, and

angular movement of the line of the cord relative to a reference plane consequent on movement of the weight.

In yet another aspect, the present invention provides a method of monitoring performance in the course of physical exercise using a weight against gravity, the apparatus including:

attaching a flexible cord to a weight which is mounted to move vertically by human exertion against the force of gravity so that at least a portion of the length of the cord moves vertically with movement of the weight; and

monitoring longitudinal movement of the flexible cord in the course of the movement of the weight.

Although the preceding summary of the invention refers to the use of weights in the course of physical exercise, it will be appreciated that the apparatus and method of the present invention are applicable not only to the use of weights, but also to other types of resistance training such as that using hydraulic or elastic resistance to forces. Accordingly, throughout this specification (including the claims) the terms 'weight' and 'weights' are used to include any apparatus that provides a suitable source of resistance to forces of physical exertion.

It will accordingly be seen that various embodiments of apparatus according to the present invention can be readily retro-fitted to existing gym equipment without major modification of the existing equipment. Other embodiments of apparatus according to the present invention can be readily used with free weights such as barbells and dumbbells without requiring the installation of fixed hardware.

It will also be seen that apparatus according to various embodiments of the present invention can generate a data stream which indicates values representing time, displacement and angle of lift of the bar of the gym equipment, or of weights.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more readily understood, preferred embodiments are described with reference to the drawings in which:

Figure 1 shows a typical gym exercise machine with a first form of preferred sensor installation.

Figure 2 shows a typical gym exercise machine with an second form of preferred sensor installation.

Figure 3 illustrates a detail of figure 1.

Figure 4 illustrates a detail of figure 2.

Figure 5 shows a sensor assembly that is a preferred feature of the present invention.

Figure 6 illustrates timing signals according to a preferred sensor of the present invention.

Figure 7 illustrates a detail of operation of a preferred feature of the present invention.

Figure 8 shows a method for using a preferred embodiment of the present invention.

Figure 9 shows the data communication paths of a preferred embodiment of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENT

The system according to various embodiments of the present invention is a gym performance analysis system which includes a sensor that can be fitted to gym equipment. Preferably there is also software for a PDA capable of interfacing to the sensor and capable of recording and later transferring data recorded from the interface to an intermediary computer, and software running on the intermediary computer capable of transferring the data via the Internet to a server computer capable of storage, analysis and reporting of the data.

The sensor identifies itself to the PDA placed on a cradle via a suitable interface, for example an electronic, RF, or optical interface. The user then selects the appropriate exercise and begins exercise. The PDA records, via the interface, all the data required for a detailed performance analysis and some real-time parameters can optionally be displayed by both visual or audio means, to assist the user while training.

A preferred embodiment of the system includes a facility to upload training files for storage and analysis via the Internet. This enables the long-term assessment of an individual's progress. The data is analysed and presented to the user in a simple format. It also facilitates the programming and downloading of training advice and exercise programs into a PDA for use in the gym. Participating gym staff and personal trainers may use the system to provide this training advice.

The PDA software and the host software are also capable of storing and reporting useful data on equipment usage patterns by using a machine and exercise identification scheme embedded in the data uploaded by users.

According to other especially preferred embodiments, the PDA client software can interface directly to aerobic fitness equipment to receive data sets representing parameters such as power, distance and duration of workout.

The embodiment of the present invention that is illustrated generally at 1 in figure 1, includes a typical gym exercise machine 3, in this case one that might be used for a 'lat' [*latissimus dorsi* muscles] pull down exercise where the user pulls on the handle 4 to lift the weights 6. In doing so the cable 7 passes over the pulleys 8 and 5 to lift the weights 6.

Rotation of the pulley 8 causes an optical interrupter 9 to rotate through the optical sensor 11. The optical sensor 11 generates a pair of phase quadrature signals which are illustrated generally at 61 and 62 in figure 6. The phase relationship between the signals 61 and 62 is determined by the direction of

rotation of the optical interrupter 9. In one direction the rising and falling edges 63 and 64 respectively, of signal 61 lead the rising and falling edges 66 and 67 respectively of signal 62. In the reverse direction, the rising and falling edges 63 and 64 respectively, of signal 61 lag the rising and falling edges 66 and 67 respectively of signal 62.

As is also shown in figure 3, a cable 12 feeds the output signals 61 and 62 of the optical sensor 11 to a sensor transceiver 13. A cradle 14 for the receipt of a handheld computer or the like 16 is mounted on the apparatus 1. The sensor transceiver 13 provides the preferred wireless optical communication path to the handheld computer 16 which is placed on the cradle 14.

The handheld computer 16 or other MCU is programmed to count the signal pulses in each direction and to determine the time at which these pulses occurred so that displacement of the weights 6 in figure 1 and the velocity of the weights 6 are measured.

Figures 2 and 4 illustrate alternative preferred forms of the invention. As with the embodiment of figures 1 and 3, the present embodiment of the invention that is illustrated generally at 1 in figure 2 includes a typical gym exercise machine 3, that might be used for a lat pull down exercise where the user pulls on the handle 4 to lift the weights 6. In doing so the cable 7 passes over the pulleys 8 and 5 to lift the weights 6. (The apparatus of figure 5 is shown in an inverted position relative to the orientation of that apparatus where it appears in figures 2 and 4.) As shown in figures 2 and 5, a cord 21 is attached to weights so that when the weights are lifted by a user the cord 14, which is wound once around a pulley 22 and coupled to the encoder 23 will be dispensed from the spring loaded cable retractor 24. In the present embodiment the encoder 23 is a low cost stepper motor, which produces a pair of signals 61 and 62 as the pulley 11 which is coupled to it rotates. The phase relationship of signals 61 and 62 is determined by the direction of rotation of the pulley 12. In one direction the rising and falling edges 63 and 64 respectively, of signal 61 lead the rising and falling edges 66 and 67 respectively of signal 62. In the reverse direction, the rising and falling

edges 63 and 64 respectively, of signal 61 lag the rising and falling edges 66 and 67 respectively of signal 62. A microcontroller circuit 24 is programmed to condition and count the pulses of the signals 61 and 62 in each direction and to determine the time at which these pulses occurred so that displacement of the weights 6 in figure 1 and the velocity of the weights 6 are measured. According to an alternative preferred forms of rotary encoder, the stepper motor encoder 23 is replaced with a commercially available optical rotary encoder.

Further according to the embodiment of figure 5, a wireless optical sensor transceiver 13 communicates the data to a nearby handheld computer or MCU (which is not illustrated in the drawings).

The assembly 15 illustrated in figure 5 is housed in a protective case which allows the assembly to be mounted in any orientation.

Figure 7 illustrates a further preferred feature of the invention that allows sensing of angular orientations during the lifting of a weight. According to this feature, the cord 21 that is attached to a weight such as a barbell passes through the apparatus 31 and the apparatus 31 is placed between the weight and the anchor point of the cord 21. The angular orientation sensor includes a cylindrical guide 33, one end of which is fixed to a the shaft 34 of an angular orientation transducer 36. The cord 21 runs through an aperture 37 which passes through a stationary base plate 36 to which the transducer 36 is mounted. Preferred forms of the transducer 36 include a variable resistor, an optical encoder and any other suitable form of rotary transducer.

It will be appreciated that the combination of an angular displacement sensor 31 together with a linear displacement sensor such as 15 will allow the simultaneous measurement of both the linear and angular movement of a cord such as 21, allowing for the computation of both linear and angular information relating to the movement of a weight. The application of well known principles of mechanics allows the calculation of parameters for performance assessment such as

acceleration,; peak acceleration; path traced; peak velocity; point of peak velocity; work done; time; and displacement.

Referring to fig 8 a gym user 29 is shown in two stages of lifting a free weight 30. A retractable cord sensor 31 is placed on the floor with its cord 21 attached to measure the lift of the free weight 30, a barbell in this case. Here the handheld computer 33 is placed on the floor in such a way as to aim its wireless interface, in this case an optical interface, at the sensor transceiver window 34.

Referring to figure 9, the wireless communication path 35 between the sensor 36 and the handheld computer 37 used to record data while training in the gym is shown. Prior to and on completion of training the handheld computer 37 is connected to an intermediary computer 38 by a temporary cable or wireless link 39. The intermediary computer 38 runs software to upload training data and download training programmes and messages via the Internet 40 to and from the server 41 respectively. The data is then reported to the user via a web, email or other Internet protocol.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Apparatus for the monitoring of performance in the course of physical exercise using a weight, which apparatus includes:

a flexible cord including an attachment portion that is attachable, directly or indirectly, to the weight or the like;

remote from the attachment portion, retracting means for retracting the cord; and

intermediate the attachment portion and the retracting means, means for generating signals which are indicative of at least one of:

longitudinal movement of the cord away from and towards the retracting means consequent on movement of the weight or the like, and

angular movement of the longitudinal line of the cord relative to a reference plane consequent on movement of the weight or the like.

2. Apparatus as claimed in claim 1, in which the reference plane is horizontal.

3. Apparatus as claimed in claim 1 or claim 2 in which the means for generating signals indicative of longitudinal movement of the cord away from the retracting means includes:

a pulley or the like which includes a circumferential portion for the receipt of a bight of the cord; and

attached to the pulley or the like, means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

4. Apparatus as claimed in any one of the preceding claims in which the means for generating signals indicative of angular movement of the longitudinal line of the cord includes:

a sleeve for receipt of the line of cord longitudinally within it and mounted such that angular movement of the longitudinal line of the cord causes corresponding angular movement of the sleeve; and

attached to the sleeve, means for converting angular movement of the sleeve into signals which are indicative of the angular movement of the line of the cord.

5. Apparatus for the monitoring of performance in the course of physical exercise by moving a weight against gravity, the apparatus including:

a weight mounted for vertical movement both with and against the force of gravity;

a flexible cord attached to the weight to move the weight by human exertion against the force of gravity; and

means for monitoring longitudinal movement of the flexible cord in the course of the movement of the weight.

6. Apparatus as claimed in claim 5 in which the means for monitoring longitudinal movement of the flexible cord includes:

a pulley over which the flexible cord passes; and

means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

7. Apparatus as claimed in claim 6 in which the means for converting rotation of the pulley into signals which are indicative of longitudinal movement of the cord includes:

an optical interruptor mounted to the pulley for rotational movement with the pulley; and

an optical sensor which generates the signals which are indicative of the longitudinal movement of the cord on rotation of the optical interruptor relative to the optical sensor.

8. Apparatus as claimed in claim 7 in which the optical interruptor includes an encoded disk that is fixed to the pulley.

9. Apparatus as claimed in claim 7 in which the encoded disk is cut, etched, painted, printed or marked by placement of adhesive labels.

10. Apparatus as claimed in claim 6 in which the means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord includes a stepper motor.

11. Apparatus as claimed in any one of the preceding claims in which the signals which are indicative of the longitudinal movement of the cord include signals in phase quadrature which indicate the direction of the longitudinal movement of the cord.

12. Apparatus as claimed in any one of the preceding claims in which the signals that are indicative of the movement of the cord are transmitted wirelessly to a micro-controller unit.

13. Apparatus as claimed in any one of the preceding claims in which the micro-controller unit is a PDA.

14. Apparatus as claimed in any one of claims 1 to 5, or any one of claims 11 to 13 as appended to claims any one of claims 1 to 5, substantially as described with reference to figures 2, 4, 5, 6, 7, 8 and 9.

15. Apparatus as claimed in any one of claims 6 to 10, or any one of claims 11 to 13 as appended to any one of claims 1 to 5, substantially as described with reference to figures 1, 3, 6, 7 and 9.

16. A method of monitoring performance in the course of physical exercise using a weight, which method includes the steps of:

attaching one end of a a flexible cord to the weight;

anchoring the other end of the flexible cord at an anchor so that the length of the cord is:

retractable towards and away from the anchor; and

maintained in a taut line as it retracts towards and away from the anchor, and

generating signals which are indicative of at least one of:

longitudinal movement of the cord away from and towards the anchor consequent on movement of the weight, and

angular movement of the line of the cord relative to a reference plane consequent on movement of the weight.

17. A method of monitoring performance as claimed in claim 16, in which the reference plane is horizontal.

18. A method as claimed in claim 16 or claim 17 in which the signals indicative of longitudinal movement of the cord away from the anchor are generated by means which include:

a pulley or the like which includes a circumferential portion for the receipt of a bight of the cord; and

attached to the pulley or the like, means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

19. A method as claimed in any one of claims 16 to 18 in which the signals indicative of angular movement of the longitudinal line of the cord are generated by means which include:

a sleeve for receipt of the line of cord longitudinally within it and mounted such that angular movement of the longitudinal line of the cord causes corresponding angular movement of the sleeve; and

attached to the sleeve, means for converting angular movement of the sleeve into signals which are indicative of the angular movement of the line of the cord.

20. A method of monitoring performance in the course of physical exercise using a weight against gravity, the apparatus including:

attaching a flexible cord to a weight which is mounted to move vertically by human exertion against the force of gravity so that at least a portion of the length of the cord moves vertically with movement of the weight; and

monitoring longitudinal movement of the flexible cord in the course of the movement of the weight.

21. A method of monitoring performance as claimed in claim 20, in which the monitoring of the longitudinal movement of the flexible cord includes the steps of:

passing a bight of the cord over a pulley so that longitudinal movement of the cord results in rotation of the pulley; and

converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

22. A method of monitoring performance as claimed in claim 21 in which the rotation of the pulley into signals which are indicative of longitudinal movement of the cord is by means which include:

an optical interrupter mounted to the pulley for rotational movement with the pulley; and

an optical sensor which generates the signals which are indicative of the longitudinal movement of the cord on rotation of the optical interrupter relative to the optical sensor.

23. A method as claimed in claim 22 in which the optical interrupter includes an encoded disk that is fixed to the pulley.

24. A method as claimed in claim 22 in which the encoded disk is cut, etched, painted, printed or marked by placement of adhesive labels.

25. A method as claimed in claim 22 in which the means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord includes a stepper motor.

26. A method as claimed in any one of claims 16 to 25 in which the signals which are indicative of the longitudinal movement of the cord include signals in phase quadrature which indicate the direction of the longitudinal movement of the cord.

27. A method as claimed in any one of claims 16 to 19, or as claimed in claim 26 as appended to any one of claims 16 to 19, substantially as described with reference to figures 2, 4, 5, 6, 7 8 and 9.

28. A method as claimed in any one of claims 20 to 25, or as claimed in claim 26 as appended to any one of claims 20 to 25, substantially as described with reference to figures 1, 3, 6, 7, and 9.

AMENDED CLAIMS

[Received by the International Bureau on 05 August 2003 (05.08.03);
New claims 13, 15-22, 36-47; claims 14, 23-35 amended; remaining claims unchanged (03 pages)]

1. Apparatus for the monitoring of performance in the course of physical exercise using a weight, which apparatus includes:

a flexible cord including an attachment portion that is attachable, directly or indirectly, to the weight or the like;

remote from the attachment portion, retracting means for retracting the cord; and

intermediate the attachment portion and the retracting means, means for generating output signals which are indicative of at least one of:

longitudinal movement of the cord away from and towards the retracting means consequent on movement of the weight or the like, and

angular movement of the longitudinal line of the cord relative to a reference plane consequent on movement of the weight or the like.

2. Apparatus as claimed in claim 1, in which the reference plane is horizontal.

3. Apparatus as claimed in claim 1 or claim 2 in which the means for generating signals indicative of longitudinal movement of the cord away from the retracting means includes:

a pulley or the like which includes a circumferential portion for the receipt of a bight of the cord; and

attached to the pulley or the like, means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

4. Apparatus as claimed in any one of the preceding claims in which the means for generating signals indicative of angular movement of the longitudinal line of the cord includes:

a sleeve for receipt of the line of cord longitudinally within it and mounted such that angular movement of the longitudinal line of the cord causes corresponding angular movement of the sleeve; and

attached to the sleeve, means for converting angular movement of the sleeve into signals which are indicative of the angular movement of the line of the cord.

5. Apparatus for the monitoring of performance in the course of physical exercise by moving a weight against gravity, the apparatus including:

a weight mounted for vertical movement both with and against the force of gravity;

a flexible cord attached to the weight to move the weight by human exertion against the force of gravity; and

means for monitoring longitudinal movement of the flexible cord in the course of the movement of the weight.

6. Apparatus as claimed in claim 5 in which the means for monitoring longitudinal movement of the flexible cord includes:

a pulley over which the flexible cord passes; and

means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

7. Apparatus as claimed in claim 6 in which the means for converting rotation of the pulley into signals which are indicative of longitudinal movement of the cord includes:

an optical interruptor mounted to the pulley for rotational movement with the pulley; and

an optical sensor which generates the signals which are indicative of the longitudinal movement of the cord on rotation of the optical interruptor relative to the optical sensor.

8. Apparatus as claimed in claim 7 in which the optical interruptor includes an encoded disk that is fixed to the pulley.

9. Apparatus as claimed in claim 7 in which the encoded disk is cut, etched, painted, printed or marked by placement of adhesive labels.

10. Apparatus as claimed in claim 6 in which the means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord includes a stepper motor.

11. Apparatus as claimed in any one of the preceding claims in which the signals which are indicative of the longitudinal movement of the cord include signals in phase quadrature which indicate the direction of the longitudinal movement of the cord.

12. Apparatus as claimed in any one of the preceding claims in which the signals that are indicative of the movement of the cord are transmitted ~~wirelessly~~ to a micro-controller unit.

13. Apparatus as claimed in claim 12 in which the signals that are indicative of the movement of the cord are transmitted to the micro-controller unit wirelessly.

14~~3~~. Apparatus as claimed in claim 12 or claim 13 ~~any one of the preceding claims~~ in which the micro-controller unit is a PDA.

15. Apparatus as claimed in any one of the preceding claims in which the means for generating output signals includes means for generating signals which indicate the nature of the physical exercises that can be performed using the apparatus.

16. Apparatus as claimed in claim 15 as appended to any one of claims 12 to 14 in which the micro-controller includes means for displaying at least one physical exercise that can be performed using the apparatus.

17. Apparatus as claimed in claim 16, further including means by which a user of the apparatus can choose a physical exercise that is displayed by the apparatus.

18. Apparatus as claimed in any one of claims 12 to 17, further including means by which exercise routines for a user may be loaded into the apparatus.

19. Apparatus as claimed in claim 18 as appended to claim 16 or claim 17 in which the at least one physical exercise that is displayed is a physical exercise that is specified in the exercise routine.

20. Apparatus as claimed in claim 18 or claim 19 in which the exercise routines for a user that may be loaded into the apparatus are chosen by the user's personal trainer.

21. Apparatus as claimed in any one of claims 12 to 20, in which the micro-controller unit includes means for uploading data from the apparatus.

22. Apparatus as claimed in claim 21 in which the uploaded data includes data about at least one of:

the physical exercises performed by a user; and

data from which maintenance requirements for the apparatus may be determined.

23~~14~~. Apparatus as claimed in any one of claims 1 to 5, or any one of claims 11 to ~~13~~22 as appended to claims any one of claims 1 to 5, substantially as described with reference to figures 2, 4, 5, 6, 7, 8 and 9.

24~~15~~. Apparatus as claimed in any one of claims 6 to 10, or any one of claims 11 to ~~13~~22 as appended to any one of claims 1 to 5, substantially as described with reference to figures 1, 3, 6, 7 and 9.

2516. A method of monitoring performance in the course of physical exercise using exercise apparatus which includes a weight, which method includes the steps of:

attaching one end of a ~~a~~ flexible cord to the weight;

anchoring the other end of the flexible cord at an anchor so that the length of the cord is:

retractable towards and away from the anchor; and

maintained in a taut line as it retracts towards and away from the anchor, and

generating signals which are indicative of at least one of:

longitudinal movement of the cord away from and towards the anchor consequent on movement of the weight, and

angular movement of the line of the cord relative to a reference plane consequent on movement of the weight.

2617. A method of monitoring performance as claimed in claim ~~16~~25~~,~~ in which the reference plane is horizontal.

2718. A method as claimed in claim 2516 or claim 2617 in which the signals indicative of longitudinal movement of the cord away from the anchor are generated by means which include:

a pulley or the like which includes a circumferential portion for the receipt of a bight of the cord; and

attached to the pulley or the like, means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

2819. A method as claimed in any one of claims 2516 to 2718 in which the signals indicative of angular movement of the longitudinal line of the cord are generated by means which include:

a sleeve for receipt of the line of cord longitudinally within it and mounted such that angular movement of the longitudinal line of the cord causes corresponding angular movement of the sleeve; and

attached to the sleeve, means for converting angular movement of the sleeve into signals which are indicative of the angular movement of the line of the cord.

2920. A method of monitoring performance in the course of physical exercise using a weight against gravity, the apparatus including:

attaching a flexible cord to a weight which is mounted to move vertically by human exertion against the force of gravity so that at least a portion of the length of the cord moves vertically with movement of the weight; and

monitoring longitudinal movement of the flexible cord in the course of the movement of the weight.

3021. A method of monitoring performance as claimed in claim 2920, in which the monitoring of the longitudinal movement of the flexible cord includes the steps of:

passing a bight of the cord over a pulley so that longitudinal movement of the cord results in rotation of the pulley; and

converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord.

3122. A method of monitoring performance as claimed in claim 3021 in which the rotation of the pulley into signals which are indicative of longitudinal movement of the cord is by means which include:

an optical interrupter mounted to the pulley for rotational movement with the pulley; and

an optical sensor which generates the signals which are indicative of the longitudinal movement of the cord on rotation of the optical interrupter relative to the optical sensor.

3223. A method as claimed in claim 3122 in which the optical interrupter includes an encoded disk that is fixed to the pulley.

3324. A method as claimed in claim 3122 in which the encoded disk is cut, etched, painted, printed or marked by placement of adhesive labels.

3425. A method as claimed in claim 3122 in which the means for converting rotation of the pulley into signals which are indicative of the longitudinal movement of the cord includes a stepper motor.

3526. A method as claimed in any one of claims 2516 to 3425 in which the signals which are indicative of the longitudinal movement of the cord include signals in phase quadrature which indicate the direction of the longitudinal movement of the cord.

36.12. A method as claimed in any one of ~~the preceding~~ claims 25 to 35, in which the output signals ~~that are indicative of the movement of the cord~~ are transmitted to a micro-controller unit.

37.13. A method as claimed in claim 1236 in which the output signals ~~that are indicative of the movement of the cord~~ are transmitted to the micro-controller unit wirelessly.

38.14. A method as claimed in claim 1236 or claim 1337 in which the micro-controller unit is a PDA.

39.15. A method as claimed in any one of ~~the preceding~~ claims 36 to 38 in which the means for generating output signals includes means for generating signals which indicate the nature of the physical exercises that can be performed using the A ~~method~~apparatus.

40.~~16~~. A method as claimed in claim ~~15~~39 as appended to any one of claims ~~12~~36 to ~~14~~38 in which the micro-controller includes means for displaying at least one physical exercise that can be performed using the ~~method.~~apparatus.

41.~~17~~. A method as claimed in claim ~~16~~40, further including means by which a user of the method can choose a physical exercise that is displayed by the ~~method~~apparatus.

42.~~18~~. A method as claimed in any one of claims ~~12~~36 to ~~17~~41, further including means by which exercise routines for a user may be loaded into the apparatus.

43.~~19~~. A method as claimed in claim ~~18~~42 as appended to claim ~~16~~40 or claim ~~17~~41 in which the at least one physical exercise that is displayed is a physical exercise that is specified in the exercise routine.

44.~~20~~. A method as claimed in claim ~~18~~42 or claim ~~19~~43 in which the exercise routines for a user that may be loaded into the apparatus are chosen by the user's personal trainer.

45. A method as claimed in any one of claims ~~12~~36 to ~~20~~44, in which the micro-controller unit includes means for uploading data from the apparatus.

46~~22~~. A method as claimed in claim ~~21~~45 in which the uploaded data includes data about at least one of:

the physical exercises performed by a user; and

data from which maintenance requirements for the apparatus may be determined.

~~27. A method as claimed in any one of claims 16 to 19, or as claimed in claim 26 as appended to any one of claims 16 to 19, substantially as described with reference to figures 2, 4, 5, 6, 7 8 and 9.~~

~~28. A method as claimed in any one of claims 20 to 25, or as claimed in claim 26 as appended to any one of claims 20 to 25, substantially as described with reference to figures 1, 3, 6, 7, and 9.~~

47. The invention as claimed in any one of the preceding claims, substantially as described with reference to the drawings.

STATEMENT UNDER ARTICLE 19(1) (RULE 46.4)

The claims have been amended to more clearly define the invention.

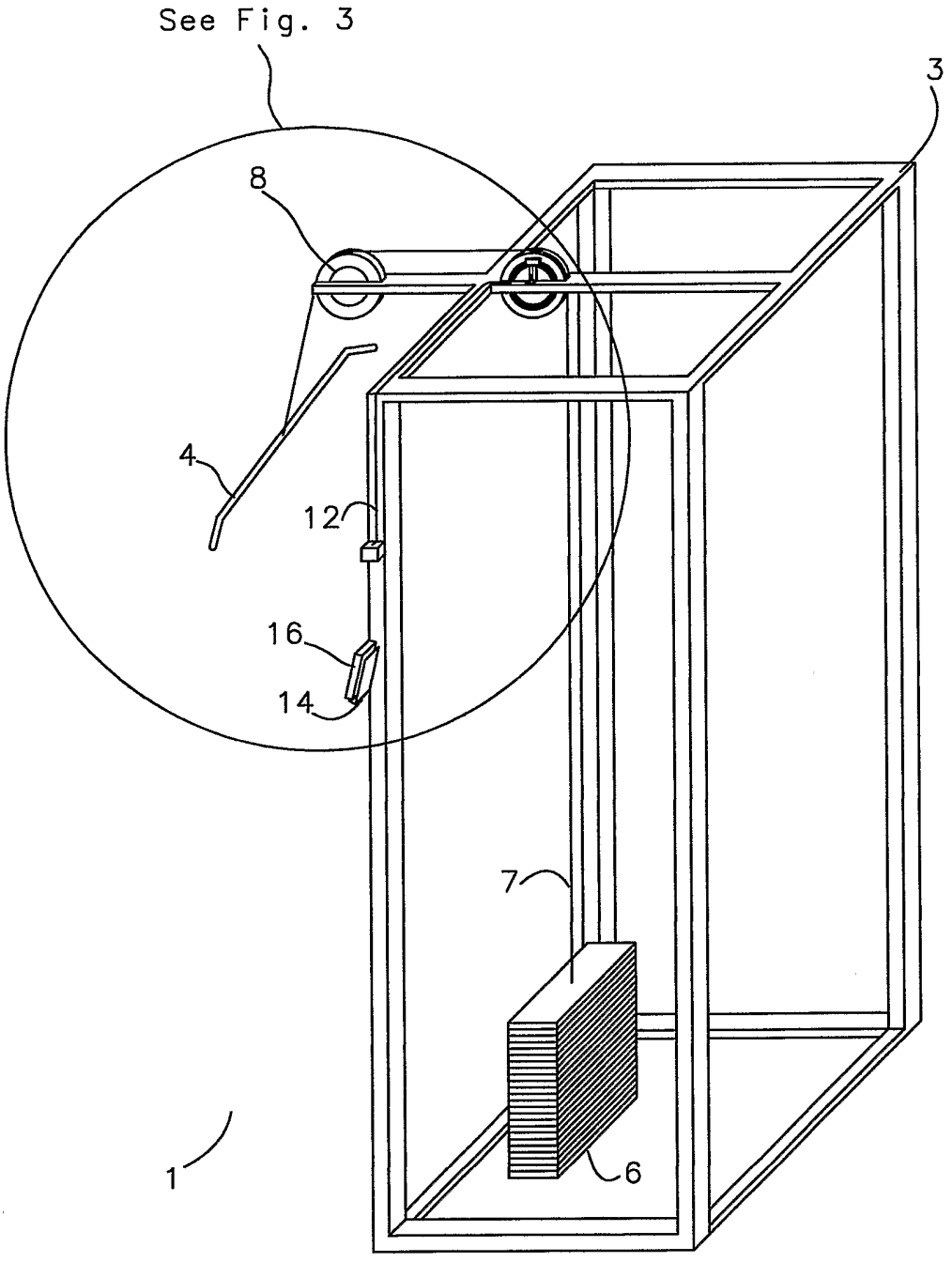


Fig. 1

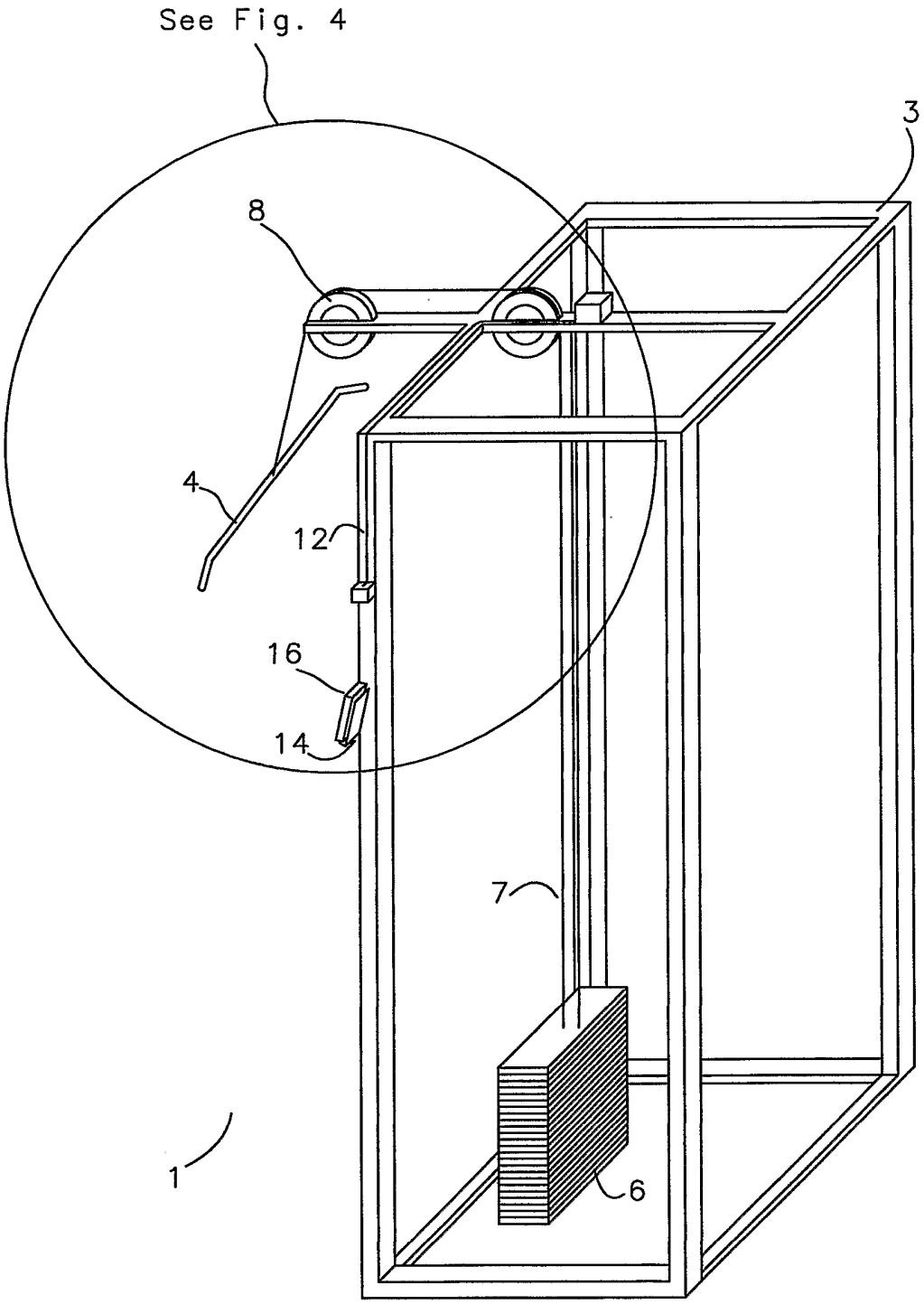


Fig. 2

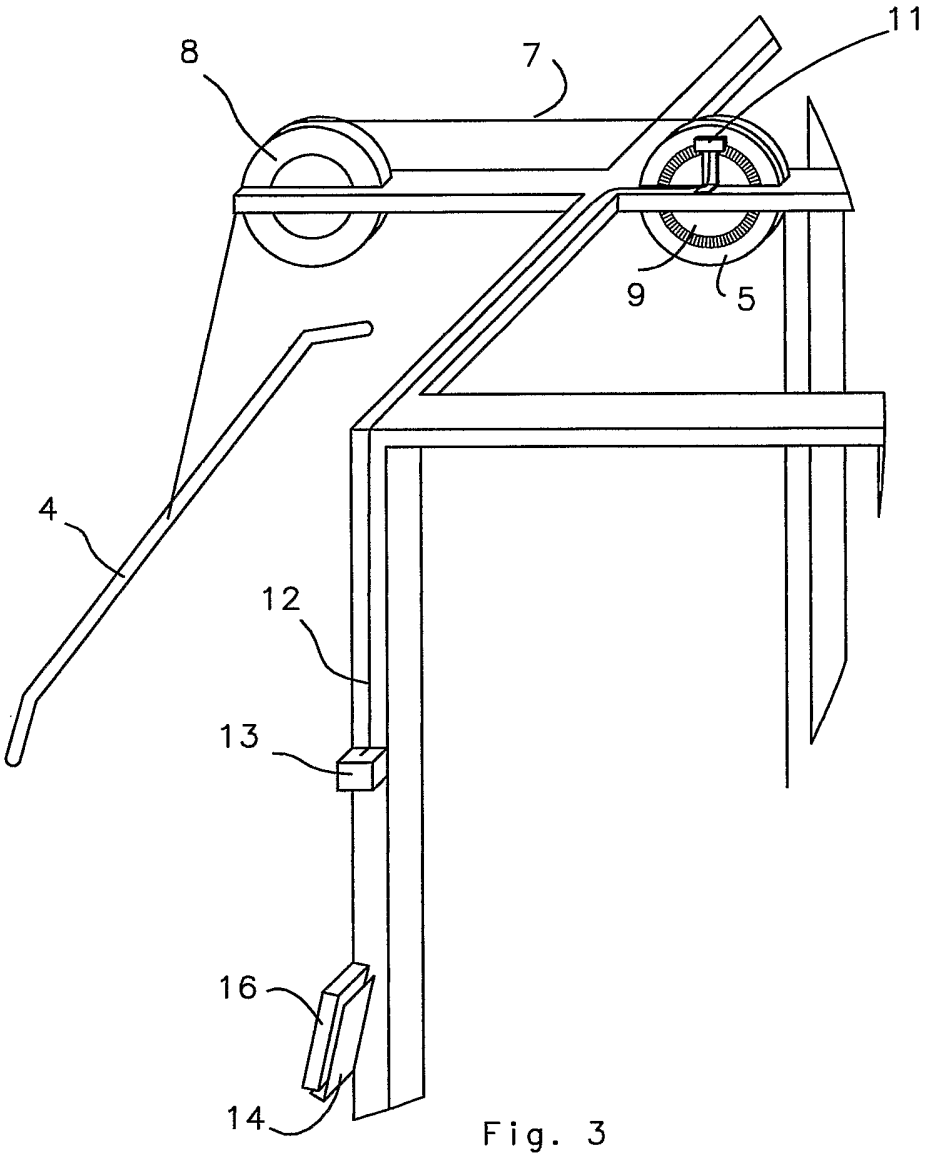


Fig. 3

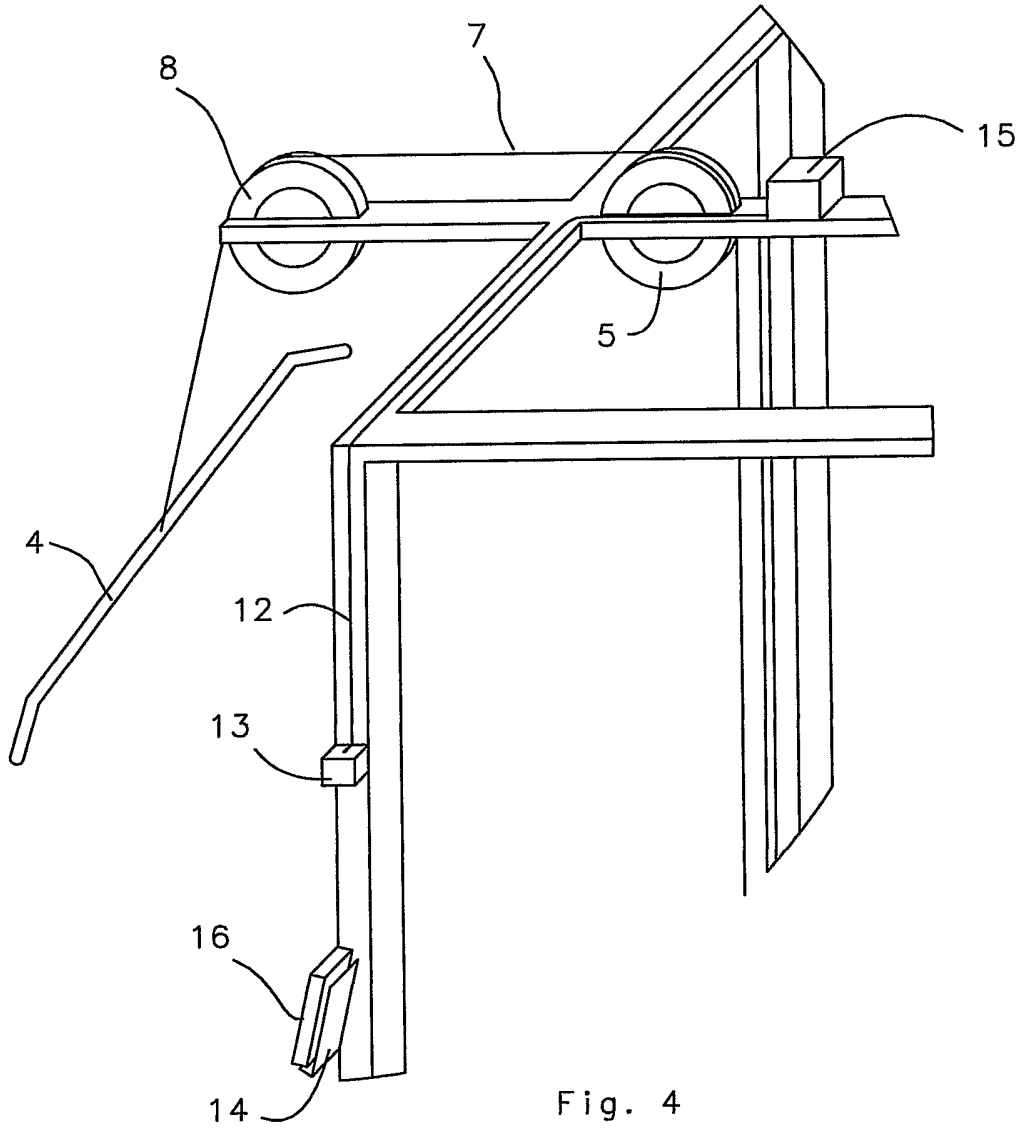


Fig. 4

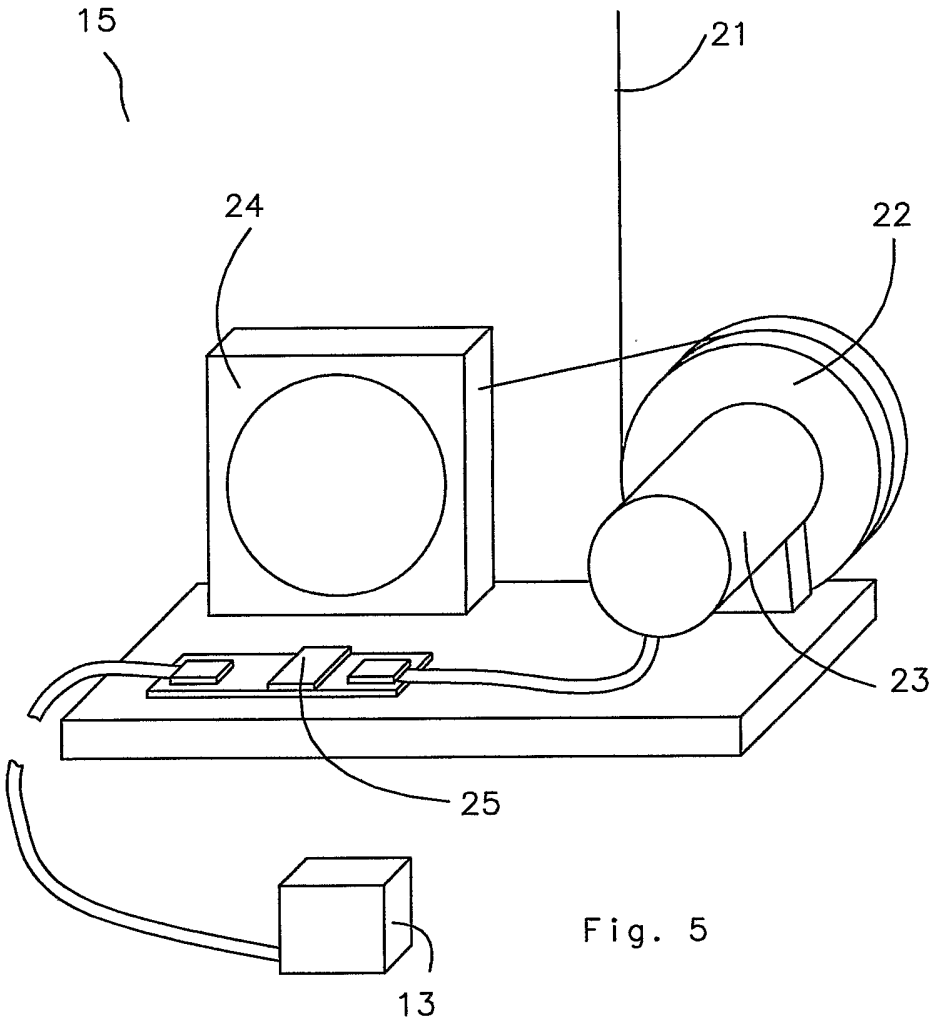


Fig. 5

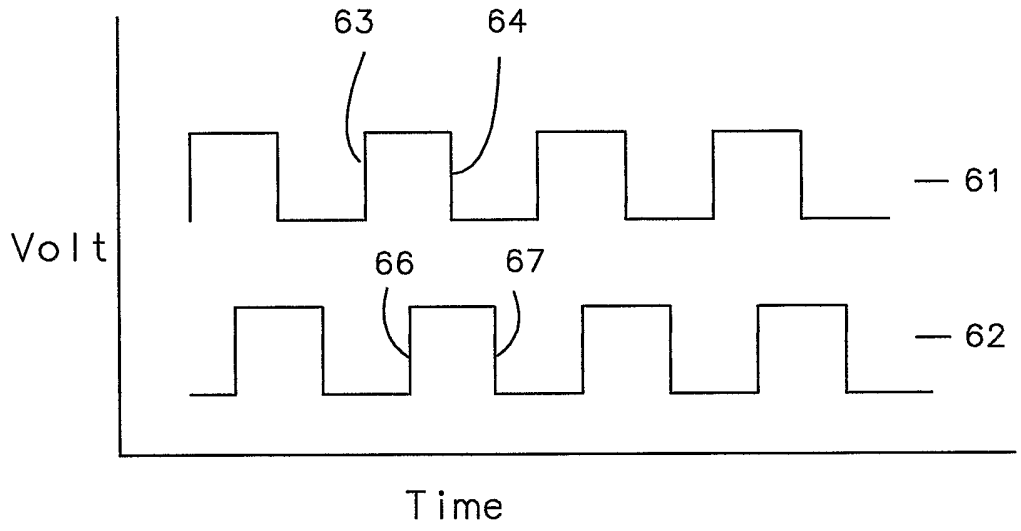


Fig. 6

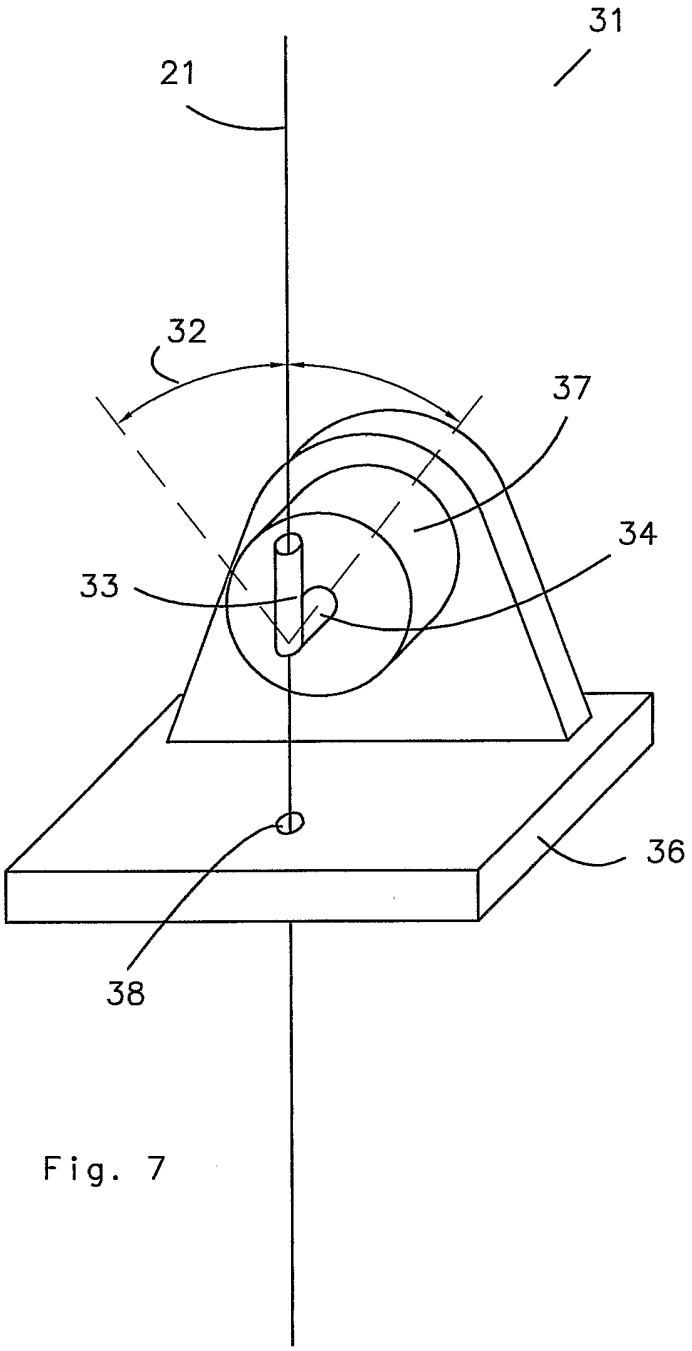


Fig. 7

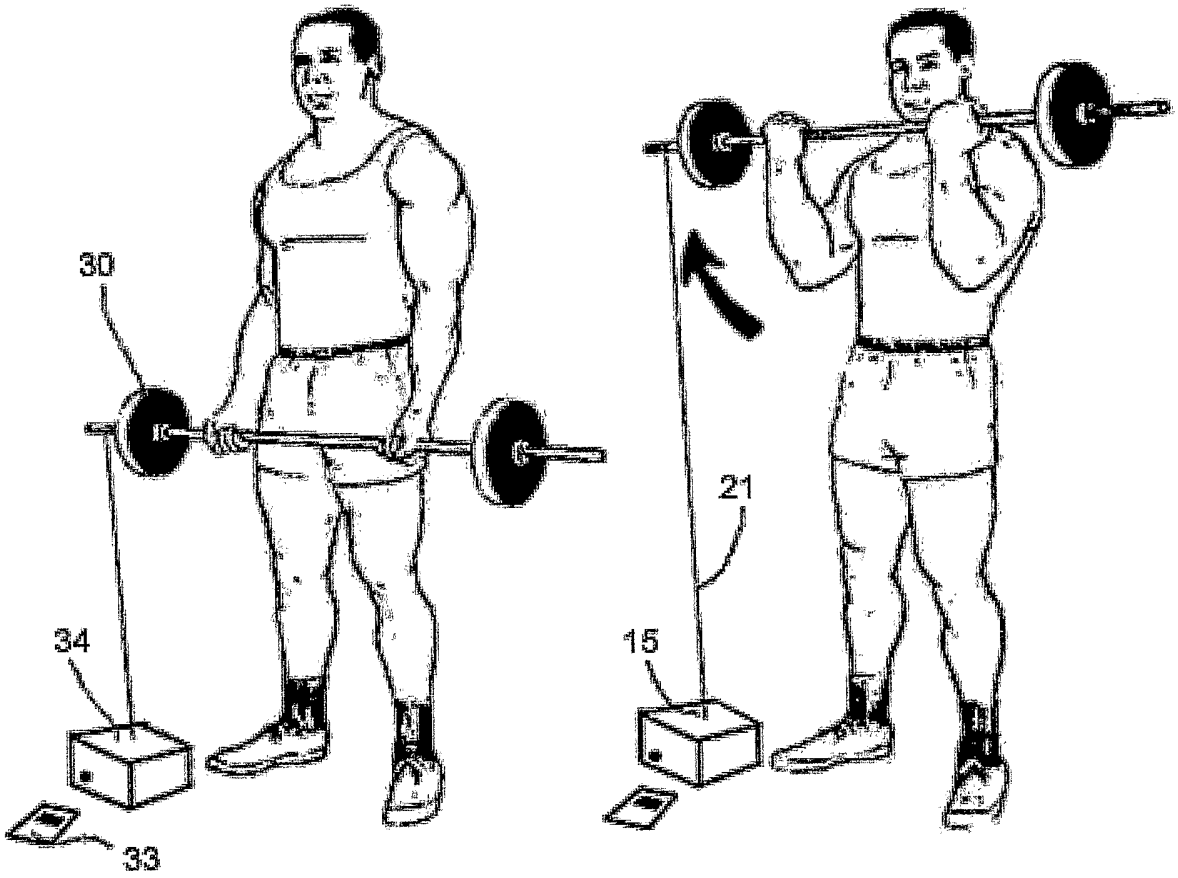


Fig. 8

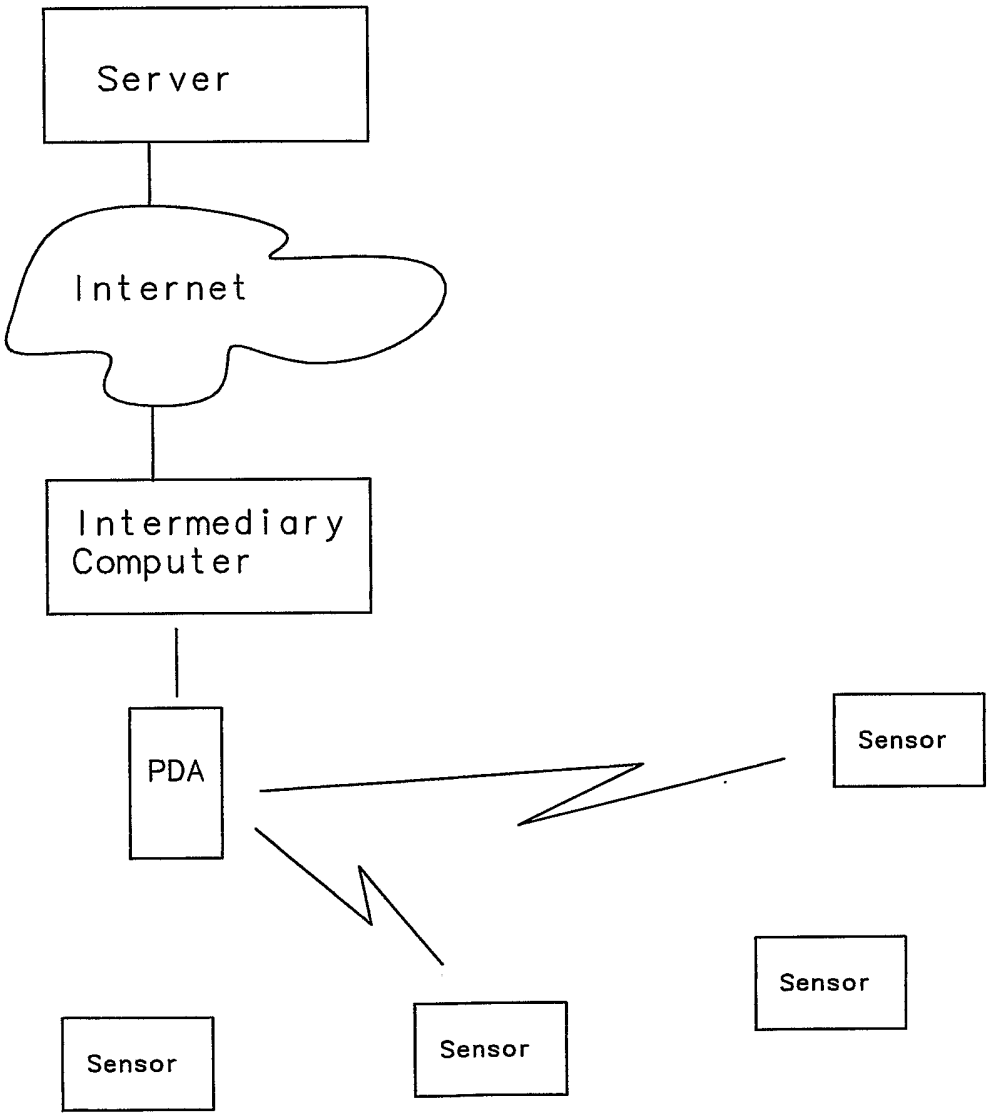

Server
Internet
Intermediary Computer
PDA
Sensor
Sensor
Sensor
Sensor

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU03/00452

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A63B 21/06, 24/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI: keywords; exercise, activity, gym, performance, repetition, strength, monitor, detect, angle, displacement, cord, cable, disk, computer, transceiver and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6231481 B1 (BROCK) 14 May 2001 See the whole document, in particular Fig 2	1, 3, 5-15, 16, 18, 20-26

☐ Further documents are listed in the continuation of Box C

☒ See patent family annex

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 May 2003	27 MAY 2003
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **VINCE BAGUSAUSKAS** Telephone No : (02) 6283 2110

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU03/00452

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

Patent Document Cited in Search Report	Patent Family Member
US 6231481	NONE

END OF ANNEX