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(54) **METHOD, SYSTEM AND MEASURING DEVICE FOR MEASURING ATHLETIC PERFORMANCE CARRIED OUT WITH WEIGHT STACK UNIT AND WEIGHT STACK UNIT**

VERFAHREN, SYSTEM UND MESSVORRICHTUNG ZUR MESSUNG ATHLETISCHER LEISTUNG MIT EINER GEWICHTSTAPELEINHEIT UND GEWICHTSTAPELEINHEIT

PROCÉDÉ, SYSTÈME ET DISPOSITIF DE MESURE PERMETTANT DE MESURER LA PERFORMANCE ATHLÉTIQUE EN UTILISANT UNE PILE DE POIDS ET PILE DE POIDS

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(56) References cited:
EP-A1- 0 691 140 EP-A2- 1 284 153
DE-A1- 10 231 861 DE-A1- 19 653 896
US-A- 4 647 038 US-A- 5 314 390
US-A1- 2003 171 188 US-B1- 6 231 481

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Description

[0001] The invention relates to a method for measuring athletic performance carried out with a weight stack unit, with the weight stack unit including weights and a lifting bar to which part of the weights are connected using a pin. The invention also relates to a corresponding system and measuring device as well as a weight stack unit.

[0002] It is known that physical performance can be measured with various measuring devices. In the follow-up of training that advances endurance, pulse and step meters, for example, are used as well as so called intelligent exercise bicycles, steppers and rowing machines. However, the usability of these measuring devices is very limited in gym training. The muscular condition can be measured isometrically or statically. However, such a measurement is not suitable as the entire training and provides a very limited amount of information even as a measurement. In practice, the physical condition can be comprehensively measured only with measuring equipment of a test laboratory. Such test equipment is generally quite expensive and difficult to install and move. Therefore they are not in use in very many gyms. The above mentioned measuring devices are not compatible with the gym equipment of different manufacturers. Training and development can be additionally followed up via the development of the amount of training performed in the gym and through increasing maximum force. This kind of follow-up can be performed using pencil and paper, for example. However, the follow-up with pencil and paper does not tell very much about the work done and the energy consumed.

[0003] Finnish utility model publication 1249 discloses a measuring device which is designed for measuring the efficiency of athletic performances and energy at belts used in the performance. However, the installation of the measuring device is difficult and it is awkward to use. In addition, it requires mains current to operate.

[0004] Publication WO 03/082411 discloses a device for measuring athletic performance carried out with a weight stack unit. In this device measuring is based on non-contacting measurement, which can be, for example, an optical distance measurement. This device, however, provides only a limited amount of information about the performed exercise.

[0005] Publication WO 96/29121 discloses a weight stack unit provided with measuring instruments for measuring athletic performance. The measuring instruments are in the weight stack unit itself, so that they cannot be used in conjunction with several weight stack units.

[0006] Publication WO 00/53266 discloses weights in connection with which there are instruments for measuring athletic performance. As the measuring instruments are in the weight stack unit itself, they cannot be used in conjunction with several weight stack units.

[0007] Publications WO 90/11049 and US 2002/0139185 also disclose equipment in connection with weight stack units. More such a measuring devices

are described in documents US-A-5314390 DE-A-102 31 861.

[0008] Thus the measuring devices according to prior art cannot provide sufficient information in a user-friendly form. On the other hand, measuring devices according to prior art providing more information are connected to the weight stack units. Then each weight stack unit requires measuring devices of its own.

[0009] The object of the invention is to provide a novel method for measuring athletic performance carried out with a weight stack unit. This novel method provides more information than before about the athletic performance. The characteristic features of this invention consist in that for determining athletic performance, pin stress is measured. Another object of the invention is to provide a novel system for measuring athletic performance carried out with a weight stack unit. With this novel system the information is provided in a more user-friendly form than before. The characteristic features of this invention consist in that the system includes pin stress measuring devices for determining athletic performance.. Still another object of the invention is to provide a novel measuring device for measuring athletic performance carried out with a weight stack unit. This novel measuring device is transferable between several weight stack units. The characteristic features of this invention consist in that the measuring device includes a pin stress measuring device for determining athletic performance. A further object of the invention is to provide a novel weight stack unit.

[0010] In weight stack units that are very widely used in gyms, the resistance is varied with weights connectable to a lifting bar. The weights may be composed of several plate-like components. As seen from above, a hole may be present in the middle of these plate-like components with a vertical lifting bar led through it. For adjusting the resistance, a desired amount of weights is fastened to the lifting bar with a pin. It was mentioned above that the lifting bar is in the vertical position, which is a common embodiment. The lifting bar can also be inclined as it is essential that the weights are moved at least partially in the vertical direction in which case the resistance is based on gravity. The weight stack unit includes a measuring device for measuring athletic performance carried out with the weight stack unit. The term 'athletics' is here understood in a wide sense including sports, exercise and corresponding physical performances. Surprisingly, for determining the athletic performance, pin stress is measured. The stress exerted on the pin depends on the mass that is lifted in the weight stack unit. By measuring the pin stress, the weight mass, i.e. the mass against which work is done during the athletic performance, is measured. When measuring the pin stress, detailed information about the athletic performance is received with the measuring device, which is detachable from the weight stack unit after the completion of the athletic performance. The method enables thus a measuring device which is easily transferrable between weight stack units. The measuring device can thus be

used in conjunction with several different weight stack units. In addition, the measuring device is suitable in connection with weight stack units of different manufacturers. Thus the measuring device is easily transportable and installable in connection with weight stack units of many manufacturers.

[0011] In one embodiment, acceleration of weights is also measured during athletic performance. During the athletic performance the weight stacks move back and forth when their speed changes. With a changing speed, acceleration is directed to the weights. The measurement of acceleration is today simple with acceleration sensors or optical means. Measuring the acceleration enables obtaining versatile information related to training based on the pin stress.

[0012] In another embodiment, the moving time of weights is also measured during the athletic performance. The athletic performance has a certain duration during which the weight stacks move back and forth. By measuring the moving time of the weights it is possible to obtain versatile information about the training. Knowing the weights' moving time and the mass of the weights moved enables obtaining versatile information related to the exercise.

[0013] The invention is described below in detail by making reference to the enclosed drawings, which illustrate some of the embodiments of the invention, in which

- Figure 1 shows a common weight stack unit including a measuring device according to the invention,
- Figure 2 is a diagrammatic basic view showing the implementation of the system according to the invention,
- Figure 3 shows a wired embodiment of the measuring device according to the invention,
- Figure 4a shows a non-wired embodiment of the measuring device according to the invention,
- Figure 4b shows the sensor component of the measuring device according to the invention provided with a pressure sensor,
- Figure 5 shows a weight stack unit according to the invention including a measuring device,
- Figure 6 is a diagrammatic view of a user interface design for a weight stack unit according to the invention, and
- Figure 7 is a flow chart showing the software of a weight stack unit according to the invention.

[0014] The weight stack unit 10 shown in Figure 1, which is commonly used in gyms, includes weights 12 and a lifting bar 14. A desired amount of the weights 12 is connected to the lifting bar 14 using a pin 16. There are several types of weight stack units and they are suitable for practising the body very extensively. The weight stack unit 10 of Figure 1 also includes a seat 18, which the exerciser can use during training. The exerciser can

also stand during training. The position of the exerciser depends on the muscles trained during training. The weight stack unit 10 also includes handles 20, which the exerciser can hold on to and through which he/she can exert force further on the weight stack unit. The force is exerted from the handles 20 further on the lifting bar 14 through wires 22 and roller wheels 24. The roller wheels 24 and the lifting bar 14 are supported to a frame 26. A desired amount of weights 12 is attached to the lifting bar 14 with a pin 16 to provide a resistance for the exercise, i.e. to produce the desired stress for the training. The lifting bar 14 and the weights 12 connected thereto with the pin 16 move in the vertical direction such that the exerciser works against gravity. This entity, consisting of weights 12 connected to the lifting bar 14 with a pin 16, is called a weight stack unit 28.

[0015] Included in connection with the weight stack unit 10 shown in Figure 1 there is a measuring device 34 for measuring the athletic performance carried out with the weight stack unit 10. Weights 12 included in the weight stack unit 10 and the lifting bar 14 are adapted to be connected to each other with a pin 16. In addition, the measuring device 34 includes a pin 16 stress measuring instrument for determining the athletic performance. In other words, the pin 16 includes a pin stress measuring instrument. In Figure 1, the pin stress measuring instrument is not shown since it is located in such a position of the pin that is inside the pin hole 32. When the measuring device 34, including a pin stress measuring instrument, is in the pin 16, the measuring device can be used in connection with many different weight stack units.

[0016] Figure 2 provides a diagrammatic basic view of a system according to the invention for measuring athletic performance carried out with a weight stack unit. The system according to the invention is designed for measuring athletic performance carried out with a weight stack unit. The weight stack unit includes weights and a lifting bar. A desired part of the weights 12 is connected to the lifting bar 14 with a pin 16 to form a weight stack unit 28. In addition, the system includes pin 16 stress measuring instruments 52 for determining the athletic performance. In the system the pin 16 includes the pin stress measuring instruments 52. More precisely, the pin stress measuring instrument 52 is in the sensor component 30.

[0017] The system according to the invention shown in Figure 2 includes a control component 36, a user interface 38, a memory 40, a computing unit 42, a display 44, control equipment 46, and data transfer equipment 48 between the last. The data transfer equipment can be wired or wireless. More precisely, in the system there is a control component 36 in connection with the weight stack unit 28 composed of weights 12, a lifting bar 14, and a pin 16. The control component 36 further includes a user interface 38, a memory 40, and a computing unit 42. The user interface 42, in turn, includes a display 44 and control equipment 46.

[0018] The system according to the invention shown in Figure 2 includes wireless data transfer equipment 58

between the sensor component 30 and the control component 36. Wireless data transfer equipment enable differentiating the sensor component and the control component. When the differentiation takes place with wireless data transfer equipment, the control component can be really freely located. This control component can be positioned on the wrist or it can be a telephone. Many devices, such as mobile phones, are already equipped with a required memory, computing unit, and user interface. In addition, mobile phones have today a bluetooth connection or similar via which a connection to the measuring device can be arranged. Thus, by programming a mobile phone to perform the necessary computation it would be very simple to create the control component of the measuring device using the mobile phone. The control component and the sensor component provided with a pin may also be composed of one single entity. With this kind of embodiment, a situation can be achieved in which the measuring device is a compact entity. Then the measuring device is used with the user interface provided in connection with the sensor component. This kind of compact entity moves easily in connection with a weight stack unit.

[0019] The sensor component 30, shown in Figure 2, of the system according to the invention includes an acceleration sensor 50. The acceleration sensor 50 is capable of collecting information about the movement of the weight stack unit 28, which information, together with the data collected from the pin with the stress measuring instrument 52, enables a versatile analysis of the exercise. In addition, the acceleration sensors can be small and they consume only little energy being thus well suitable for use also in applications that operate with batteries or small accumulators. Acceleration sensors can be located in places in which measuring acceleration would otherwise be difficult. When measuring acceleration and entering the mass of the resistance as the input data, an application can be provided which monitors and stores the number of performances based on acceleration.

[0020] The sensor component 30, shown in Figure 2, of the system according to the invention includes time measuring means 54. The time measuring means 54 can be used to collect information about the movement of the weight stack unit 28, which information, together with the data collected from the pin with the stress measuring instrument 52, enables a versatile analysis of the exercise.

[0021] When measuring distance or acceleration besides time, an application can be provided in which the measuring device can determine the work done and the energy used as well as the efficiency by entering the mass of the resistance. An acceleration sensor is advantageously used with the time measuring means thanks to its small size and accurate measuring results. Measuring distance, for example, based on a laser would be much more difficult. A measuring device provided with both time measuring means and an acceleration sensor is a very advantageous embodiment as it can be manu-

factured in very many forms. A central requirement is that the pin of the measuring device includes pin stress measuring instruments for determining the athletic performance.

[0022] The measuring instrument for the mass of weights moved during the athletic performance is a pin stress measuring instrument. When the mass measuring instrument is the pin stress measuring instrument provided in the pin, the weights and the lifting bar are locked with an instrument that measures the mass. Thus the fastening of the weight mass measuring device does not require separate actions as the pin must in any case be set for adjusting the resistance.

[0023] Figure 3 shows a measuring instrument 34 according to the invention. The measuring instrument 34 is composed of two basic entities, namely a sensor component 30 and a control component 36. The sensor component 30 includes, an accelerator sensor 50, pin stress measuring instruments 52, and time measuring means 54. The sensor component 30 also includes a pin 16, by which the sensor component can be conveniently connected to the weight stack unit. Advantageously the sensor component 30 includes a strain gauge transducer 56 for measuring the mass. Data transfer means 48 are set between the components, used for conveying collected information towards the control component 36. For collecting information, the A/D transformer of a microcontroller 62 included in the measuring device can be used.

[0024] In the measuring device 34 shown in Figure 3, the stress measuring instrument 52 is a strain gauge transducer 56. The strain gauge transducer 56 is adapted in connection with the pin 16 in such a manner that it actually measures the pin deflection. When the strain gauge transducer stretches, the resistance increases and, in turn, the resistance decreases due to compression. The pin deflection, again, depends on the resistance against which the exercise is carried out. The use of a strain gauge transducer is advantageous since strain gauge transducers are affordable in price and safe in operation. The power consumption of strain gauge transducers is also low, which favors their use. In other words, the pin deflects the more, the more there are weights connected to the lifting bar with the pin. The work and efficiency are calculated based on these measured parameters. In addition, it is possible to compute other parameters that describe the training.

[0025] Figure 4a shows a measuring device 34 according to the invention. The sensor component 30 and the control component 36 of the measuring device communicate with each other with wireless data transfer equipment 58. For transferring data within the sensor component 30, wired data transfer equipment 64 is used, because wired equipment is simpler and more economical to manufacture. An embodiment using wireless data transfer enables differentiating the sensor component 30 and the control component 36. One advantageous embodiment of the control component is attachable to the wrist. Thus it is easy for the exerciser to continuously

follow up the proceeding of the training. The broken line arrow in Figure 4 illustrates the data transferred between the sensor component 30 and the control component 36. Although the arrow is double-headed, data is advantageously transferred only from the sensor component towards the control component. When the data transfer is one-directional, information can be entered in the sensor component in other ways. Thus the sensor component can be made smaller than before and the power consumption can also be minimized. Minimizing the power consumption is very important when using a small battery or accumulator as the power source. For this reason, particular attention must be paid to the power consumption when designing the physical implementation of a wireless version as well as the programming. For saving energy, the components should be turned off when not in use. Also, in selecting the components, emphasis should be laid on components consuming only little energy. For minimizing the power consumption, the collection and transfer of data must also be considered. In one embodiment, it is not useful to transfer data continuously to the control component. In this case, data is collected in the memory of the sensor component and transferred to the control component in a greater amount at once. Besides minimizing the power consumption, monitoring the voltage state of the power source is important to avoid being suddenly out of power. The voltage state is monitored with a voltmeter 60. During the measurement, the data is stored in the RAM memory of the measuring device since the values change all the time. Storing in a ROM memory is slower and consumes more energy than storing in a RAM memory. Storing in the ROM memory is done only after the physical exercise has been completed and measuring is finished. The location of the memories must be weighed up based on the power consumption, for example.

[0026] Figure 4 shows a measuring device 34 according to the invention. The pin 16 includes a pin stress measuring instrument 52. In the sensor component 30, a strain gauge transducer 56 is used for measuring the mass. Acceleration, in turn, is measured with an acceleration sensor 50. The measurement of time is based in the solution according to the figure on the vibration frequency of a microcontroller 62 in which case separate time measuring means are not required. In other words, the frequency of the microcontroller is selected as suitable and the determination of time is based on this frequency. The microcontroller 62 itself is used for gathering the measuring data. The measuring data is transferred from the microcontroller further to wireless data transfer equipment 58 using wired data transfer equipment 64. The data is delivered wirelessly to the control component 36, which accommodates computing devices and a user interface. The user interface is used with the control equipment 46 and data is read from the display 44. The sensor component can also include a user interface which at its simplest can include only a switch for turning off the sensor component. The user interface can include

even more complicated information, particularly if the sensor component is used together with a computer and the results are transferred to the computer only later. The user interface must be versatile also in case the data transfer to the control component is one-directional.

[0027] Figure 4b shows the sensor component 30 of a measuring device 34 according to the invention provided with a pressure sensor 57. In this case, the pin of the measuring device 34 includes a pin stress measuring instrument 52 for determining the athletic performance. In the embodiment according to the figure, the pin is adapted to contact the weights at its ends and the lifting bar by the center, at the pressure sensor. In this case one pressure sensor is sufficient, which measures the force conveyed by the lifting bar to the weights via the pin. When using a pressure sensor, the demand for calibrating the device decreases since when the measuring takes place with a pressure sensor, the effect of pin deformation is reduced.

[0028] Overall, the pin stress measuring instrument included in the measuring device can be of a very many different type. It is essential that the pin stress measuring instrument is capable of measuring the force against which the exerciser works. Thus it can be said that the mass of the weights is measured. The measurement of mass, i.e. the pin stress, can be implemented in many ways, such as with diaphragm or strain gauge transducers. Advantageously, the mass measuring instruments are on the pin surface. Very advantageously, an acceleration sensor and time measuring means are used with the pin stress measuring instrument or the mass sensor. Then the results can be utilized very extensively. The invention is very advantageous particularly when using a weight stack unit in which the weights do not move in the fully vertical direction. In such a weight stack unit, it is only the vertical element of the weight mass that functions as resistance. When the sensor component measures the mass as well, the work, consumed energy, and efficiency can be calculated without inputting the mass of the weight stack functioning as resistance. This facilitates the use remarkably since it is difficult for the user to know which part of the mass resists the movement and to enter this as input data to the measuring device.

[0029] Figure 5 shows a weight stack unit 10 according to the invention including a measuring device 34. The measuring device 34 includes a sensor component 30 for measuring at least one parameter. The measuring device 34 can also include a control component 36 having a display 44. The proceeding of the performance can be monitored on the display. As monitoring the display is not always easy, the measuring device advantageously includes signalling equipment. A signalling device can be a piezo buzzer, for example. The signalling equipment can be used to guide the exerciser in performing the exercise. A desired number of performances or the energy consumption can be preprogrammed in the measuring device. When achieving this level, the measuring device gives a signal indicating that the exercise can be stopped.

Besides an acoustic signal, the indication can be based on a led or a flashing display. It is essential for such signalling equipment that the user receives the information in such a form that he/she notices it during the performance. However, if the user calculates the amount of training him/herself or carries out exercises as long as he/she can, such signalling equipment can be disabled.

[0030] The bidirectionality between the measuring device and the user is very essential. In bidirectionality, the user, who can be the exerciser him/herself or the instructor, enters the targets to the measuring device. The measuring device controls training based on these targets. The targets can be defined, for example, as repetitions with certain weights or as energy consumption. The measuring device thus has intelligence to guide the exerciser based on the data entered. For guiding, the measuring device compares programmably the measuring data to preset targets, which can be general ones or a precise training program. The training program can be detailed including precise information on the resistance, repetitions and the equipment to be used. A general target, in turn, can be, for example, consumed energy or the efficiency level of performance. Once the targets have been entered to the measuring device, the measuring device guides the user. Guiding takes place with guiding equipment which can include lights and sounds, for example.

[0031] The training program can be adjusted based on information received from a pulse meter or other device measuring the development of the physical condition and training. Then the training program can be, for example, relieved if the user has made more other physical exercises.

[0032] The measuring device used in the weight stack unit according to Figure 5 can additionally include a bus enabling the measuring device to communicate with a computer. The communication bus used with the computer can be, for example, a serial port or an USB. From these, the USB is very common in the present-day computers. A software installed in a computer can be used to monitor the training really extensively, since a lot of information can be obtained from the data with a large display and high processing capacity. In the light of this information, for example, the exerciser or his/her training instructor can follow up the proceeding of the training.

[0033] The measuring device presented in connection with Figure 5 includes sensors for determining acceleration and mass as well as time measuring means. By adding a possibility to enter the mass of the weights to this measuring device, the measuring device can also be used with many such training units in which weights are not connected with a pin. Such training units are used for practicing the leg muscles, for example. Advantageously, also the angle in which the weights are supported to move can be entered in the measuring device. Then it will be possible to calculate that part of the weight mass which is in the vertical direction.

[0034] The calculation of results is based on the known

laws of mechanics. The work done during training and thus the consumed energy are determined using information received from the mass and acceleration sensors. One alternative for the calculation is that the acceleration sensors are used to measure accelerations at a selected frequency and the stack offset is computed based on these momentary accelerations and time, i.e. the frequency used. The strain gauge transducer, in turn, measures the force which gives the mass when gravity is taken into account. The measurement of mass is thus carried out when the weights are in a static condition. When the offset, mass and acceleration in each time interval are known, the work within this time interval can be calculated. The total work can be calculated by summing up the calculated partial works. Although the work could be calculated according to the dynamically measured force, momentary acceleration and dynamically measured mass are advantageously used in calculating the force. This embodiment is advantageous since acceleration sensors are very accurate and fast-reacting. Force measurement based on the pin deflection, in turn, is slightly slower in reacting to a force change. In other words, if the dynamic force received from a strain gauge transducer measuring the deflection was used in calculation, the results would become inaccurate due to the delay contained in the system.

[0035] In addition to the force, also the offset is required for calculating the work. The offset can be calculated using the formula: $\text{acceleration} \times \text{time}^2$. As the sampling frequency is constant, the time change between two measuring points can be calculated with the formula: $1/\text{sampling frequency}$. Then the offset is calculated with the formula: $\text{acceleration}/\text{sampling frequency}^2$. The works performed between the samplings can be calculated with the formula: $\text{mass} \times \text{momentary acceleration}^2 / \text{sampling frequency}^2$. The total work is calculated by summing up the works performed between the samplings. The efficiency and static work are correspondingly calculated separately for each sampling moment and summed up finally.

[0036] The efficiency, repetitions and much more can also be calculated from the exercise, for example, the maximum force based on the maximum acceleration. Processing of extensive information is advantageously carried out with a computer.

[0037] Parameters describing the static work performed by man can also be calculated based on collected data. This is because even maintaining the weights in place is work when considering the matter from the point of view of the exerciser. Static work by the exerciser can be modelled with the product of force and time, for example. When calculating the results, attention should be paid to their interpretation because they are not much of use if misinterpreted. For example, when calculating static work, the product of force and time does not necessarily tell much. More illustrative could be, for example, the product of the second power of force and the time. In this connection, no stand is taken as to which is an advanta-

geous calculation formula, but the intention is to merely put forward that this kind of interpretations can be made based on the data.

[0038] The number of measurable parameters can also be increased besides acceleration, mass and time. One possible additional parameter would be the distance. Increasing the number of measurable parameters increases the number of measuring sensors. As the number of measuring sensors increases, the manufacturing costs of the measuring device and the power consumption increase. Advantageously, the number of sensors is limited to include the acceleration sensor and the pin stress measuring instrument, i.e. the mass sensor. Then an embodiment can be achieved in which the desired information is accurately received but using resources in vain is avoided. In addition, a measuring device that includes only two measuring sensors and time measuring means can be made very small. In selecting the measurable parameters, it is essential that the parameters can be measured using known methods, in which the sensors are small and consume little energy.

[0039] The measuring device must be calibrated before use. The calibration binds the analogue voltage value received from the sensor to correspond to a certain measuring parameter value. When the mass of the weight stack unit is determined by measuring the deflection of the pin going through it, the voltage value received from the strain gauge transducer measuring the deflection must be related to the mass. Thus the value provided by a certain mass is utilized in the calibration. For the calibration of acceleration, in turn, the gravitational pull of the earth is utilized, which causes constant acceleration. Based on this constant acceleration, it is possible to determine 1G acceleration with the acceleration sensor while the -1G acceleration can be determined by turning the acceleration sensor upside down. With these, corresponding accelerations can be determined for the signal received from the acceleration sensor.

[0040] Figure 6 shows one embodiment of the user interface for a measuring device according to the invention. The user is first in the main menu status 68 where he/she selects the Exercise 70, Settings 72 or Results 74. If the user selects the item Exercise 70, a menu is displayed from which the user can select the Training Unit One 76, Training Unit Two 78, and so on. The user selects the training unit which he/she wants to use. The training units can of course have been named with more describing names. When the user selects the desired training unit, the measuring device starts measuring the exercise. Then the user can start training. The selection of the training unit is important in that various training units can require a separate calibration. When the measuring device is separately calibrated for each training unit, an extremely accurate result is achieved. The menu of the measuring device can also be implemented in such a way that the mass measurement is calibrated separately for each performance time. This allows achieving a simpler menu. However, in an advantageous embodi-

ment several training units can be ready calibrated and named. Convenient training can be achieved with this kind of application. As the users normally frequent only one or a few gyms, calibration need not be performed many times.

[0041] The demand for calibration can be reduced by designing the pin in such a way that it works in connection with many weight stack units. In other words, the pin deflection can be adjusted through the design such that a measurement taken with, for example, a strain gauge transducer functions in connection with many weight stack units. The pin design is thus of remarkable importance as regards the operation of the equipment.

[0042] By selecting Settings 72 from the user interface shown in Figure 6, the user can access to the adjustment of the measuring device settings. After this, the user selects from five alternatives, which are Display 84, Sound 86, Calibration 88, Signal 90 and Time 92. From the item Display 84 the user can adjust the display settings. Adjustable display properties include, for example, brightness and information displayed during the exercise. From the item Sound 86, the user can choose how he/she wants to use the acoustic signal. An acoustic signal can be used, among others, to provide information on the proceeding of training, e.g. the completion of a certain number of repetitions. The item Calibration 88 accesses the calibration function. As the weights included in a weight stack equipment have holes of many sizes and the bar thicknesses vary, the measuring device must be separately calibrated for the weight stack units used. Calibrations of several weight stack units can advantageously be stored in the measuring device in which case training is very smooth after the calibration. By selecting Signal 90 the user can monitor the signal coming from the measuring pin. This option does not normally come in question, but if communication problems or failed calibrations are suspected, the user can simply check the signal coming from the sensors. Subprograms can be coded in the measuring device for indicating automatically any appearing problems. By selecting Time 92 the user can access to setting the time and date of the measuring device. When the time and date are correctly set, the exerciser or the instructor can easily monitor performances later when the time of performance is stored at correct day and time.

[0043] By selecting Results 74 the user can access a menu including four items: Browse 94, Transfer 96, Print 98, Clear 100. By selecting Browse 94 the user can browse the results of the exercises. By selecting Transfer 96, in turn, the user can transfer the results to a computer. And by selecting Print 98 the user can print the results of the exercises on paper via a serial port, USB, or Bluetooth. When the user selects the function Clear 100, the results of all exercises are cleared.

[0044] It is also possible to preprogram in the measuring device with a computer and/or the user interface, depending on the embodiment of the measuring device, which kind of weight stack units are planned for perform-

ing the exercises with, in which case the measuring device guides the training. The measuring device also automatically retrieves the correct calibrations for each weight stack unit. The programming can be performed by the trainer, for example, in which case the exerciser does not need to concentrate on thinking about the balance and proceeding of the practice. The measuring device thus functions as a good tool for the instructor when appropriately programmed.

[0045] Although the software is an essential part of the measuring device, it is not analyzed in this connection in a very thorough manner. As the software can be implemented in very many ways, the below presented timings provide only one solution possibility from among really many alternatives. When the measuring device is turned on, initializations are performed. The performance of the actual main program is started after this. The main program 102 is illustrated in Figure 7. The main program 102 simply retrieves the function to be performed from the main menu 68, the functions including Exercise 70, Settings 72 and Results 74 as described above. The main program calls a subprogram included in the main menu to perform the function selected by the user of the measuring device. Each menu used in the measuring device and the functions included in it can be implemented using various kinds of subprograms. A subprogram included in each menu can draw or write its own graphic appearance on its own. In this kind of embodiment the task of the actual main program is very small.

[0046] One application for such a measuring device may be to provide help in the calibration of pulse meters. The problem in using pulse meters is that people have different pulse levels even at the same stress level. This measuring device can thus be used for calibrating pulse meters in order to output more accurate values from these. The measuring device according to the invention reveals the energy consumption through the weight stack unit training. By comparing the energy consumption value received to that received with a pulse meter, the measuring device can be used to help the calibration of the pulse meter.

[0047] A measuring device provided with a pin can also be used in connection with another unit than a weight stack unit. One application for a measuring device provided with a pin is a finger press in which the pressing elements are connected together with a spring. The spring can be so dimensioned that it functions in connection with the same pin that is used with the weight stack units. On the other hand, the pin included in the measuring device can be connectable with quick clamping allowing thus to replace the pin of the measuring device. The pin to be replaced can be of a different size in which case it can be used to measure the performance in many applications. Around a measuring device provided with a pin, training device solutions of even a completely new type can be developed in which measuring is based on the pin. It is essential that the sensor component provided with the pin is connected to the control component that

computes the results.

[0048] Although in the most advantageous embodiment, acceleration, mass and time are measured, the inventive idea can be applied in many other ways. Then it may be that the results are not as extensive or the applicability is more difficult. The invention is not limited to the forms and design presented in the drawings but different solutions are possible within the limits of the inventive idea set forth in the independent claims.

Claims

1. A method for measuring athletic performance carried out with a weight stack unit, with the weight stack unit (10) including weights (12) and a lifting bar (14), in which method a desired amount of the weights (12) is connected to the lifting bar (14) using a detachable pin (16) having a stress exerted by the weights (12), **characterized in that** the stress of the pin (16) is measured and athletic performance is determined according to the measured stress.
2. A method according to claim 1, **characterized in that** acceleration of weights (12) is also measured during the athletic performance.
3. A method according to claims 1 or 2, **characterized in that** the moving time of the weights (12) is also measured during the athletic performance.
4. A measuring device (34) for measuring athletic performance carried out with a weight stack unit, with the weight stack unit (10) including weights (12) and a lifting bar (14), to which a desired amount of the weights (12) is adapted to be connected with a detachable pin (16), **characterized in that** the measuring device (34) includes a pin stress measuring device (52) for determining the athletic performance.
5. A measuring device according to claim 4, **characterized in that** the pin stress measuring device (52) is a strain gauge transducer (56).
6. A measuring device according to claim 4, **characterized in that** the pin stress measuring device (52) is a pressure sensor (57).
7. A measuring device according to claims 4 - 6, **characterized in that** the measuring device (34) includes an acceleration sensor (50).
8. A weight stack unit, **characterized in that** it includes a measuring device (34) according to any of claims 4 - 7.
9. A system for measuring athletic performance carried out with a weight stack unit, with the weight stack

unit (10) including weights (12) and a lifting bar (14), to which a desired amount of the weights (12) is adapted to be connected with a detachable pin (16), **characterized in that** the system includes a measuring device (34) according to any of claims 4 - 7 for determining the athletic performance.

10. A system according to claim 9, **characterized in that** the system includes a control component (36), a user interface (38), a memory (40), a computing unit (42), a display (44), control equipment (46), and data transfer equipment (48) between the last.
11. A system according to claim 10, **characterized in that** wireless data transfer means (58) are set between the sensor component (30) and the control component (36).

Patentansprüche

1. Zum Messen einer mit einem Gewichte (12) und eine Hebestange (14) umfassenden Gewichtsstapel-Gerät (10) zu erbringenden Sportleistung dienendes Verfahren, bei dem ein gewünschter Teil der Gewichte (12) durch einen lösbaren Stift/Bolzen (16), der unter der von den Gewichten verursachten Spannung steht, mit der Hebestange (14) verbunden ist, **dadurch gekennzeichnet, dass** die Spannung des Stiftes (16) gemessen und die Sportleistung entsprechend der gemessenen Spannung bestimmt wird.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** während der Sportleistung auch die Beschleunigung der Gewichte (12) gemessen wird.
3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** während der Sportleistung auch die Bewegungszeit der Gewichte (12) gemessen wird.
4. Messvorrichtung (34) zum Messen einer mit einem Gewichtsstapel-Gerät zu erbringenden Sportleistung, wobei das Gewichtsstapel-Gerät (10) Gewichte (12) und eine Hebestange (14), mit der ein gewünschter Teil der Gewichte (12) durch einen lösbaren Stift (16) verbunden werden kann, umfasst, **dadurch gekennzeichnet, dass** zu der Messvorrichtung (34) ein Stiftspannungs-Messmittel (52) zur Bestimmung der Sportleistung gehört.
5. Messvorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** das zum Messen der Stiftspannung dienende Messmittel (52) aus einem Dehnungsmessstreifen-Wandler (56) besteht.
6. Messvorrichtung nach Anspruch 4, **dadurch ge-**

kennzeichnet, dass das zum Messen der Stiftspannung dienende Messmittel (52) aus einem Drucksensor (57) besteht.

7. Messvorrichtung nach den Ansprüchen 4 bis 6, **dadurch gekennzeichnet, dass** die Messvorrichtung (34) einen Beschleunigungssensor (50) umfasst.
8. Gewichtsstapel-Gerät, **dadurch gekennzeichnet, dass** es eine Messvorrichtung (34) nach irgendeinem der Ansprüche 4 bis 7 umfasst.
9. Zum Messen einer mit einem Gewichte (12) und eine Hebestange (14) umfassenden Gewichtsstapel-Gerät (10) zu erbringenden Sportleistung dienendes System, bei dem ein gewünschter Teil der Gewichte (12) durch einen lösbaren Stift (16) mit der Hebestange (14) verbunden werden kann, **dadurch gekennzeichnet, dass** das System eine Messvorrichtung (34) nach irgendeinem der Ansprüche 4 bis 7 zur Bestimmung der Sportleistung umfasst.
10. System nach Anspruch 9, **dadurch gekennzeichnet, dass** das System ein Steuerteil (36), eine Benutzerschnittstelle (38), einen Speicher (40), ein Display (44), Steuermittel (46) sowie Datenübertragungsmittel (48) zwischen den Vorgenannten umfasst.
11. System nach Anspruch 10, **dadurch gekennzeichnet, dass** zwischen dem Sensorteil (30) und dem Steuerteil (36) drahtlose Datenübertragungsmittel (58) vorhanden sind.

Revendications

1. Méthode pour mesurer une performance sportive exécutée avec un appareil à colonne de poids, où l'appareil à colonne de poids (10) comprend des poids (12) et une barre de levage (14), dans laquelle méthode un ensemble voulu des poids (12) est relié à la barre de levage (14) à l'aide d'une goupille amovible (16) sur laquelle les poids (12) exercent une contrainte, **caractérisée en ce que** la contrainte sur la goupille (16) est mesurée et que la performance sportive est déterminée selon la contrainte mesurée.
2. Méthode selon la revendication 1, **caractérisée en ce que** l'accélération des poids (12) est également mesurée pendant l'exécution de la performance sportive.
3. Méthode selon la revendication 1, **caractérisée en ce que** la durée du déplacement des poids (12) est également mesurée pendant l'exécution de la performance sportive.

4. Instrument de mesure (34) pour mesurer une performance sportive exécutée à l'aide d'un appareil à colonne de poids où l'appareil à colonne de poids (10) comprend des poids (12) et une barre de levage (14), à laquelle il est possible de relier une partie des poids (12) avec une goupille (16) amovible, **caractérisé en ce que** l'instrument de mesure (34) comprend un instrument (52) pour mesurer la contrainte sur la goupille pour déterminer la performance sportive. 5
10
5. Instrument de mesure selon la revendication 4, **caractérisé en ce que** l'instrument (52) pour mesurer la contrainte sur la goupille est un transducteur à extensomètre (56). 15
6. Instrument de mesure selon la revendication 4, **caractérisé en ce que** l'instrument (52) pour mesurer la contrainte sur la goupille est un capteur de pression (57). 20
7. Instrument de mesure selon l'une quelconque des revendications 4 à 6, **caractérisé en ce que** l'instrument (34) comprend un accéléromètre (50). 25
8. Appareil à colonne de poids, **caractérisé en ce qu'il** comprend un instrument de mesure (34) selon l'une quelconque des revendications 4 à 7.
9. Système pour mesurer une performance sportive exécutée à l'aide d'un appareil à colonne de poids où l'appareil à colonne de poids (10) comprend des poids (12) et une barre de levage (14), à laquelle il est possible de relier une partie des poids (12) à l'aide d'une goupille (16) amovible, **caractérisé en ce que** le système comprend un instrument de mesure (34) selon l'une quelconque des revendications 4 à 7 pour déterminer la performance sportive. 30
35
10. Système selon la revendication 9, **caractérisé en ce que** le système comprend un composant de contrôle (36), une interface utilisateur (38), une mémoire (40), une unité de calcul (42), un écran (44), des moyens de contrôle (46) et des moyens de transfert de données (48) entre ces derniers. 40
45
11. Système selon la revendication 10, **caractérisé en ce qu'il** y a des moyens de transfert de données sans fil (58) entre le composant capteur (30) et le composant de contrôle (36). 50

55

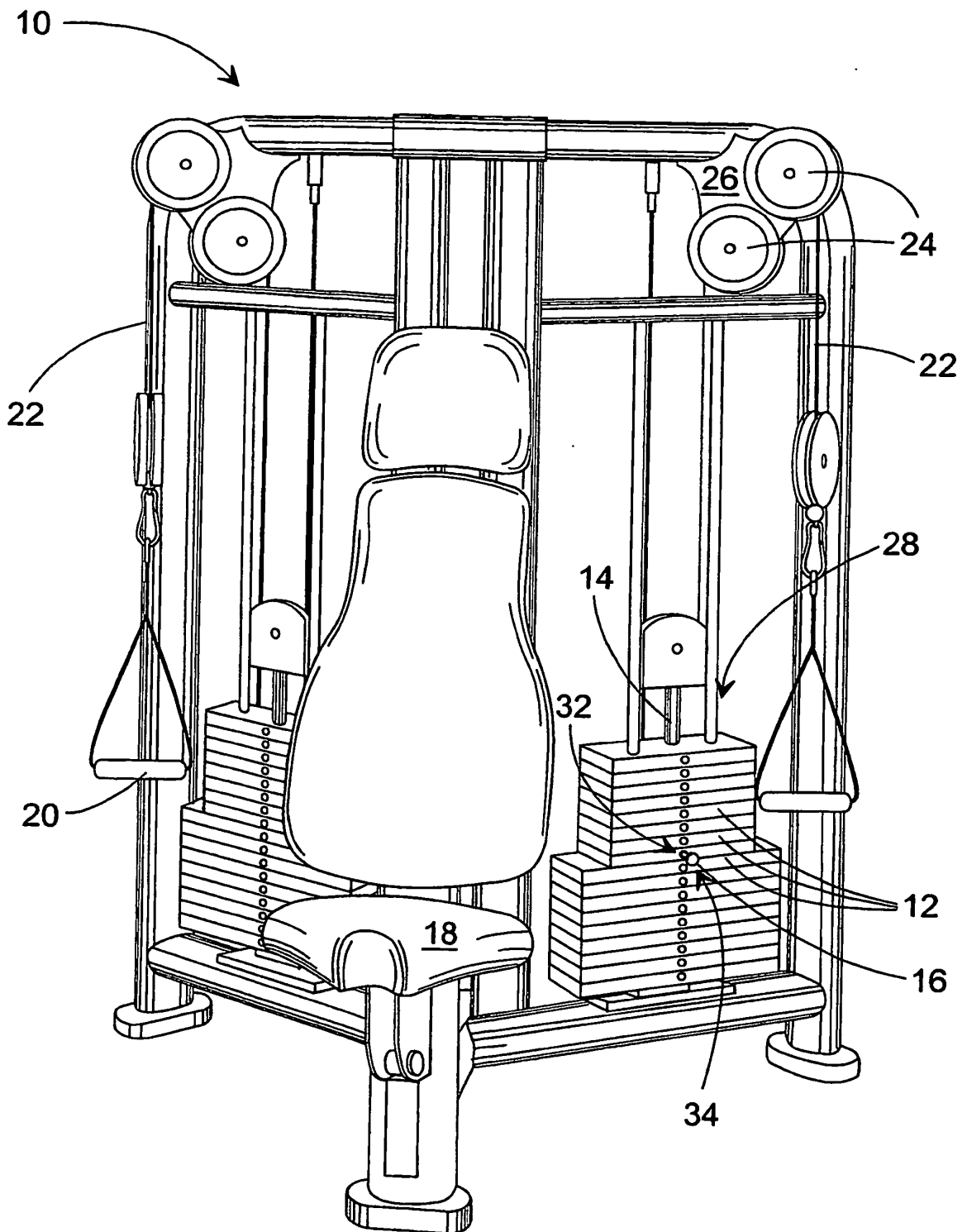


Fig. 1

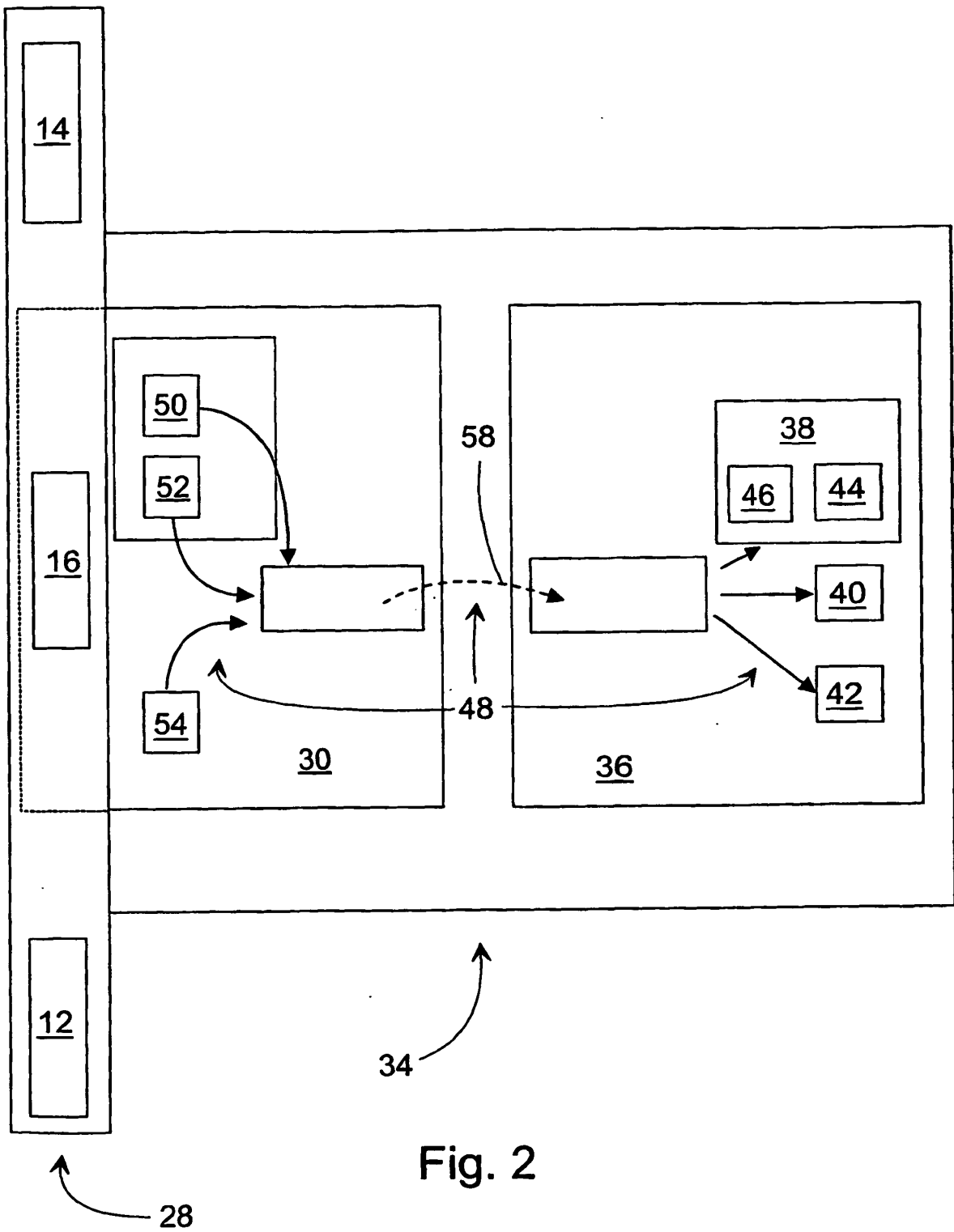


Fig. 2

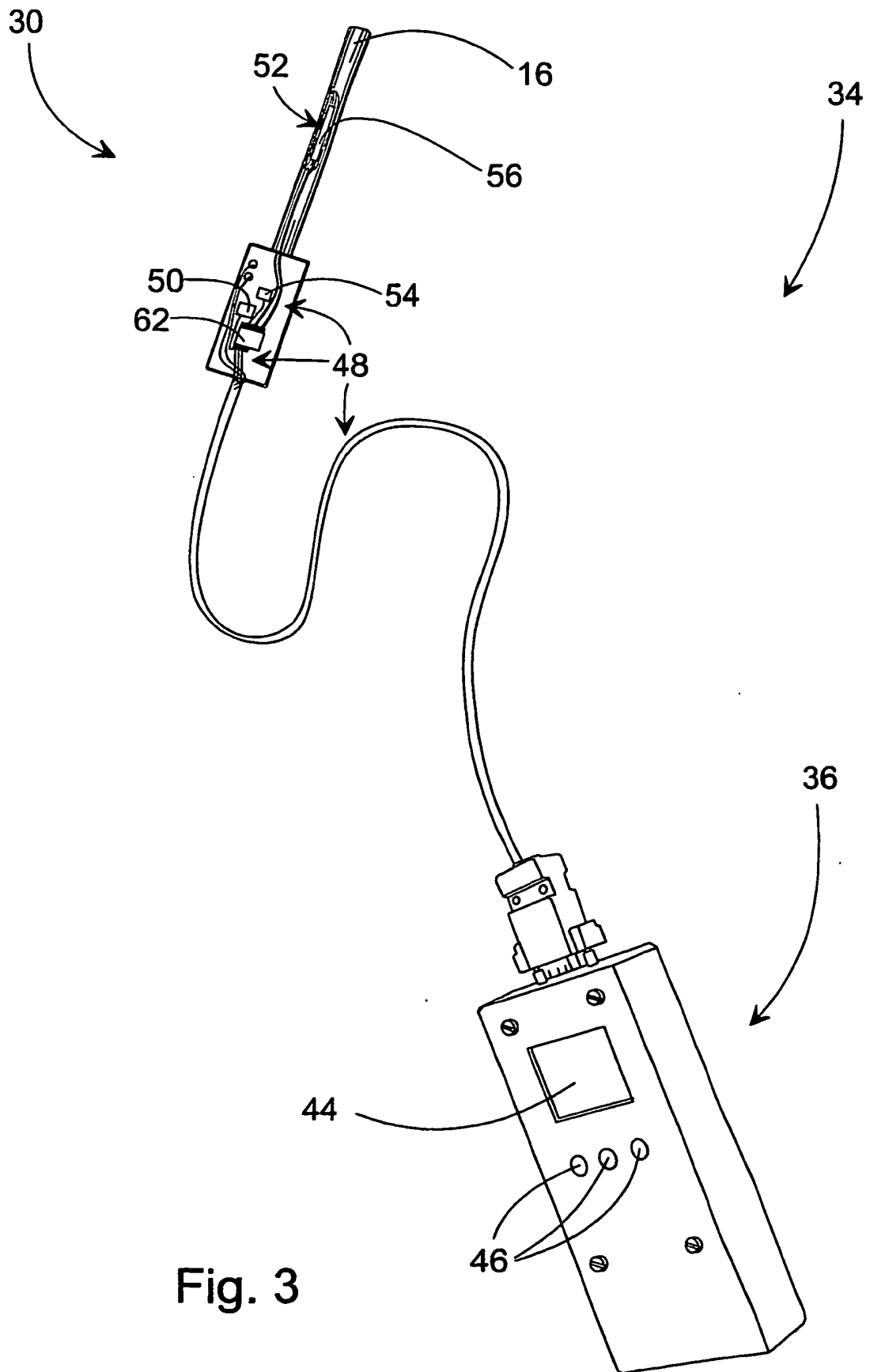
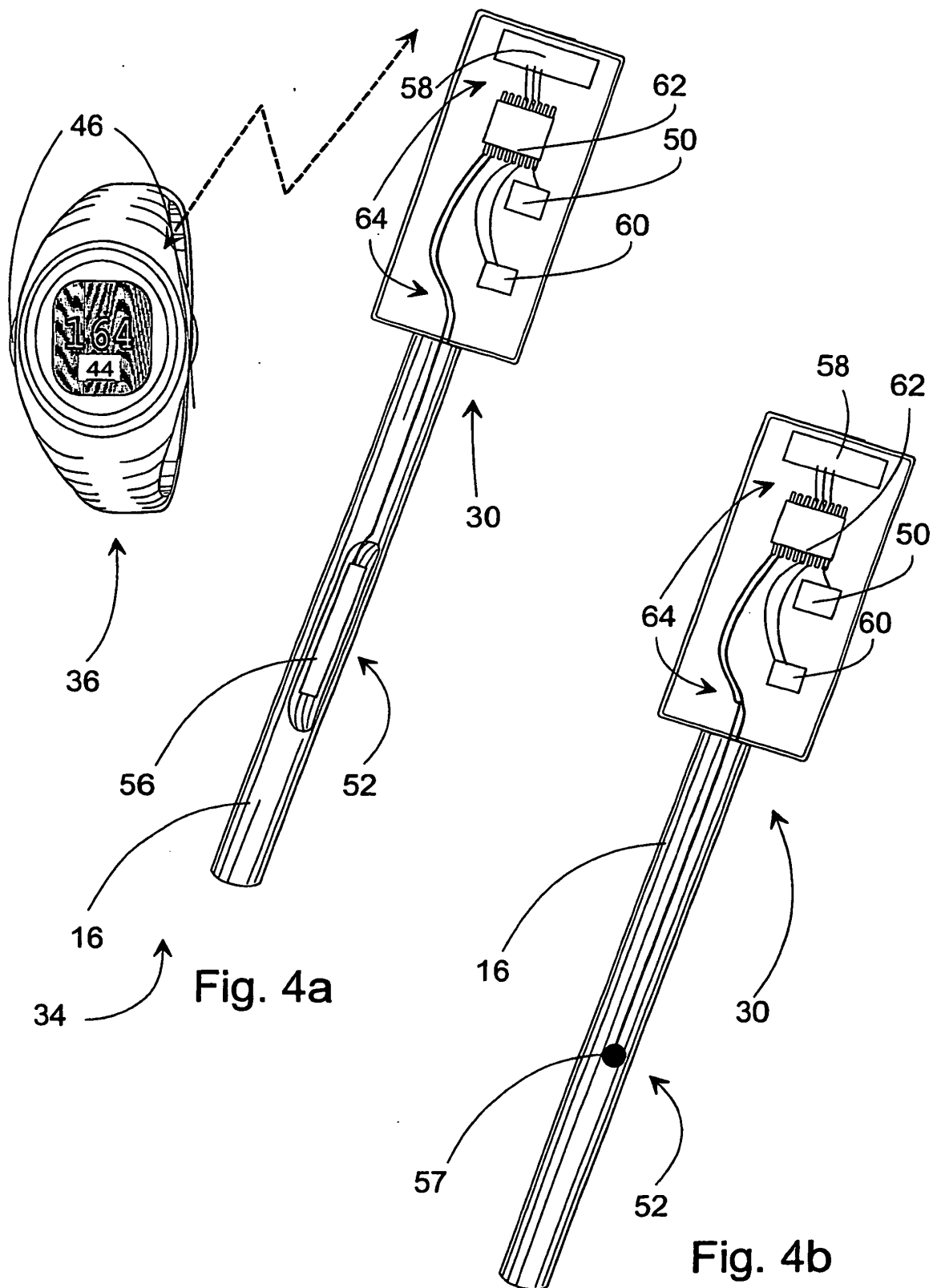


Fig. 3



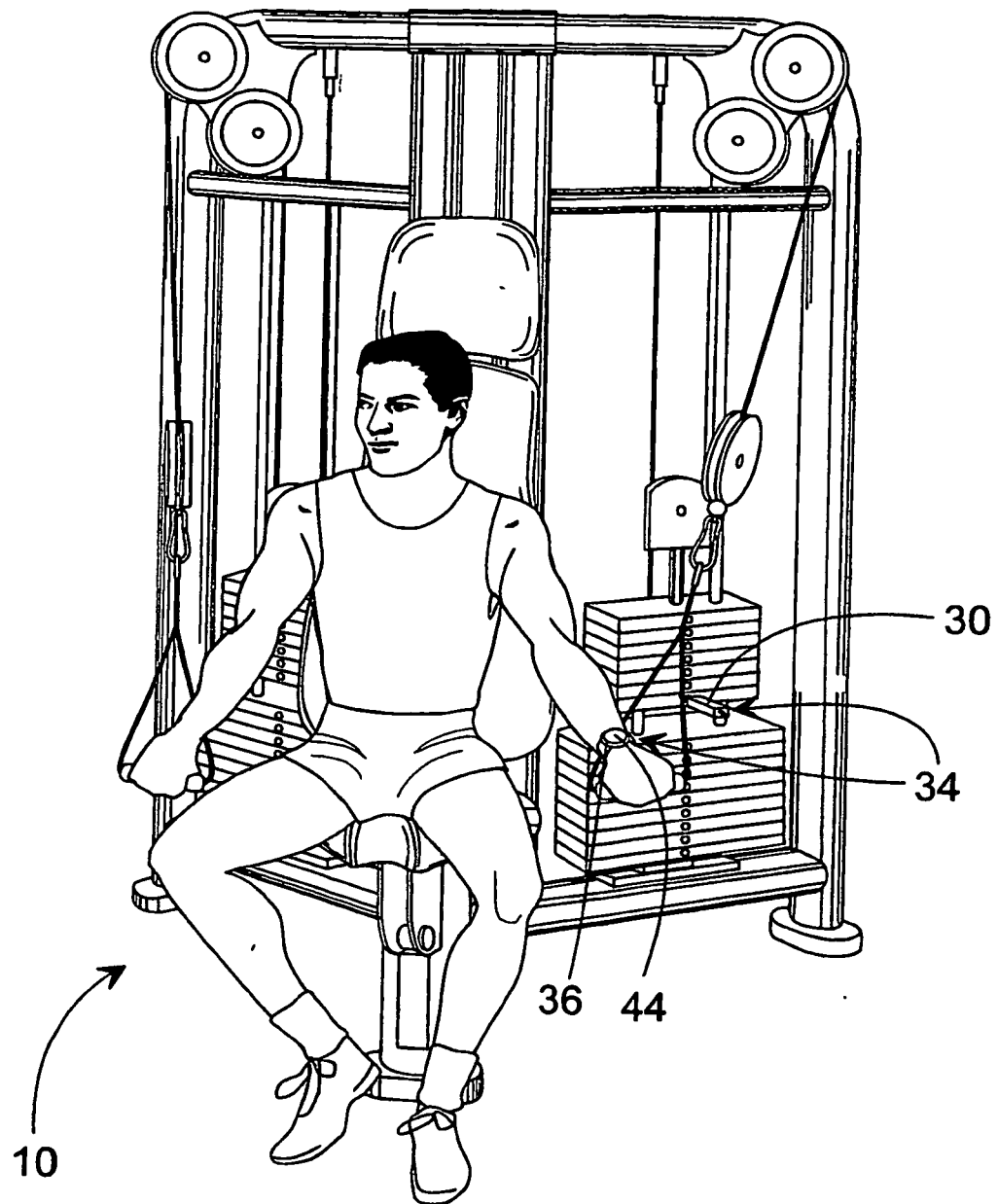


Fig. 5

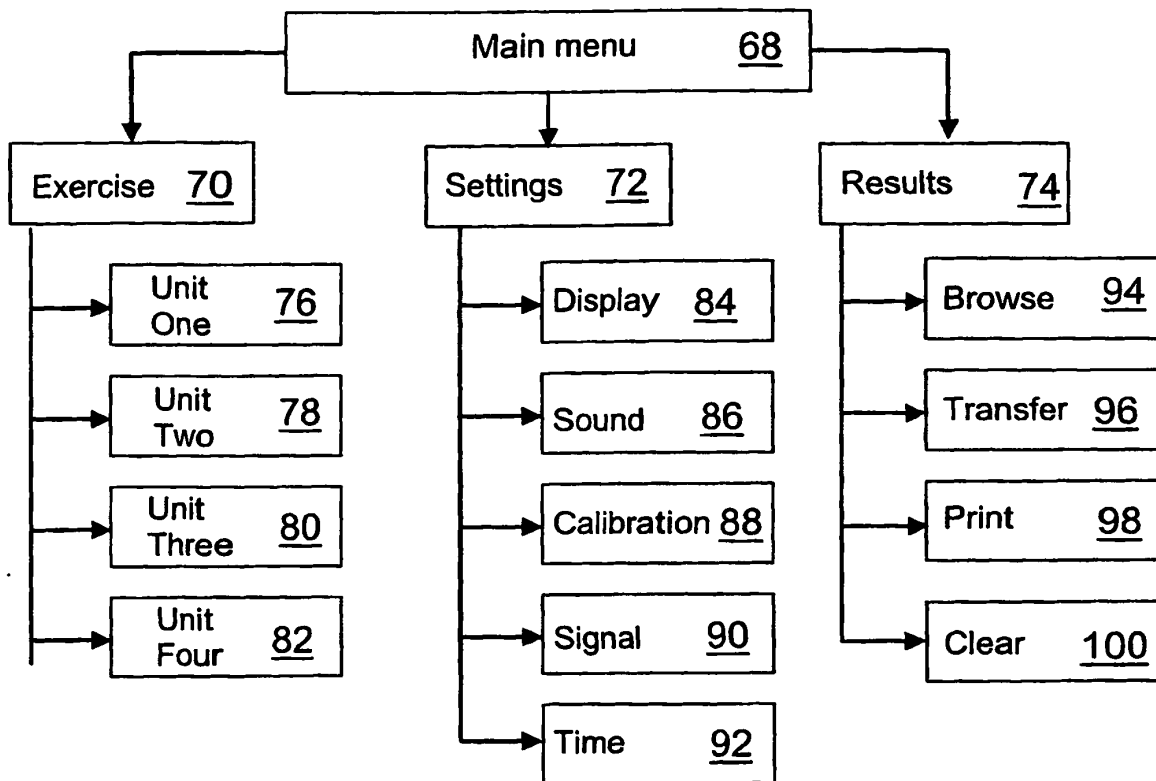


Fig. 6

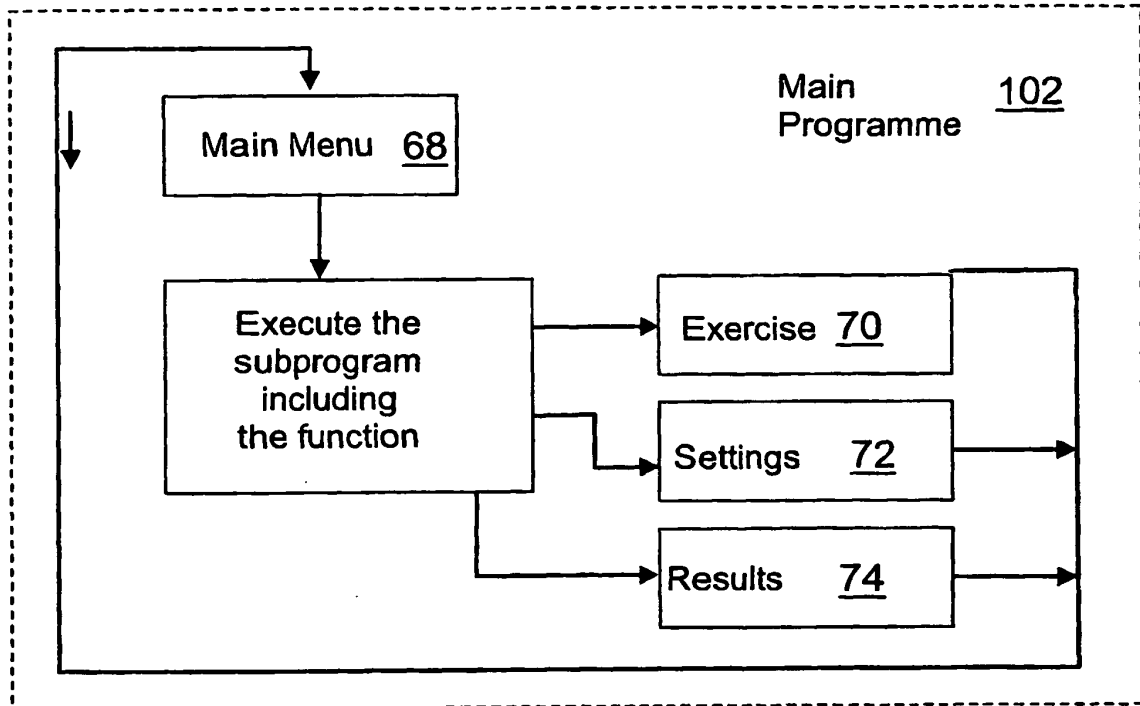


Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- FI 1249 [0003]
- WO 03082411 A [0004]
- WO 9629121 A [0005]
- WO 0053266 A [0006]
- WO 9011049 A [0007]
- US 20020139185 A [0007]
- US 5314390 A [0007]
- DE 10231861 A [0007]