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(54) **A HAND-HELD PHYSIQUE TRAINING DEVICE, A METHOD FOR PHYSIQUE TRAINING AND A PHYSIQUE TRAINING KIT**

(57) A device and a method for physic training. The physique training device (100, 200, 400, 600a, 600b, 700, 700a, 700b) comprises a tubular handle (102, 202) to accommodate one or more resistance bands (130, 230, 330, 430, 630, 730), a first force measurement means (110, 210, 510, 610) and a second force measurement means (120, 220, 520, 520, 620), a first computing means (140, 240, 340, 540, 640) connected to the first force measurement means and to the second force measurement means. The method for physique training comprises measuring a voltage readings of the ring-shaped force measuring sensors by a first force measurement means and by a second force measurement means of a hand-held physique training device, converting the measured voltage readings to a raw resistance values, calculating the raw resistance values to a training load values.

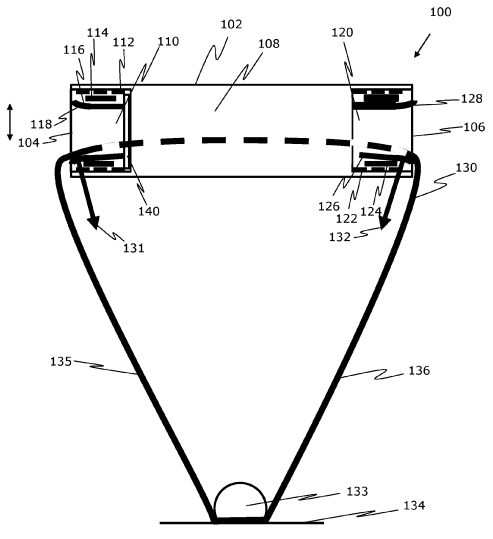

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure relates generally to exercise equipment, and more specifically, to hand-held physique training devices.

BACKGROUND

[0002] Dumbbells and resistance bands are both well-known physique training means for strength training exercises, but both, when used alone, have their limitations. Thus, combining a dumbbell and a resistance band provides several advantages, e.g., adding a resistance band to a dumbbell can provide additional resistance and variety to the workouts. By using a resistance band in combination with a dumbbell, the user can increase the load on muscles. The resistance bands can help the user to achieve a greater range of exercises than the user would be able to achieve with just the dumbbell. Resistance bands are lightweight and easy to pack, making them a convenient addition to dumbbell workouts, which enables the user to take them along when travelling or use anywhere when there is no access to a gym. However, when attaching a resistance band to a dumbbell, there are several different problems.

[0003] For a more efficient training measuring a load and repetitions is necessary. In known solutions there is a sensor attached to the resistance band. This enables therefore to use only dedicated resistance bands, but gyms, recreational centres, hospitals, people at home, etc. have already existing resistance bands available that would become useless. This also limits the usage of multiple different bands simultaneously.

[0004] Further, such solutions enable to measure only elongation and do not provide repeatable results regarding the resistive load. The known solutions in addition do not enable to measure load and repetitions and other parameters during exercising and training.

[0005] Different resistance bands have different characteristics and their characteristics change over time. Resistive load is dependent on characteristics (material, width, thickness), elongation and stretch (more elongation means higher resistive force) of the resistance band. Thus, when characteristics of the resistance band change the values of the resistive loads also change over time during elongation and stretching of the resistance band. Therefore loads, i.e., the resistive forces, experienced by users during training with resistance bands are not correctly measurable.

[0006] Therefore, in light of the foregoing discussion, there exists a need to overcome the aforementioned drawbacks associated with how to measure the load and repetitions of dumbbell workouts.

SUMMARY

[0007] The aim of the present disclosure is to provide means to measure the load and repetitions of dumbbell workouts. The aim of the disclosure is achieved by a hand-held physique training device, a method for physique training, a physique training kit and a computer program for physique training as defined in the appended independent claims to which reference is made to. Advantageous features are set out in the appended dependent claims.

[0008] Additional aspects, advantages, features and objects of the present disclosure would be made apparent from the drawings and the detailed description of the illustrative embodiments construed in conjunction with the appended claims that follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The summary above, as well as the following detailed description of illustrative embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the present disclosure, exemplary constructions of the embodiments of the disclosure are shown in the drawings, with references to the following diagrams wherein:

Fig. 1 is a front section view of a hand-held physique training device according to an embodiment of the present disclosure;

Fig. 2 illustrates a front section view of the hand-held physique training device according to a second embodiment of the present disclosure;

Fig. 3 is a side view of the embodiment of the hand-held physique training device shown in figure Fig. 2 illustrating load delivery and distribution to the force measurement means;

Fig. 4a-FIG. 4d illustrate the uneven placements of one or more resistance bands in an inner space of a handle of the hand-held physique training device;

Fig. 5a and Fig. 5b show circuit diagrams according to the embodiments of the present disclosure;

Fig. 6 illustrates a physique training kit with a block diagram of electronic components and a method for physique training according to an embodiment of the present disclosure;

Fig. 7a-Fig.7e illustrate examples of the usage of the physique training kit comprising one or more hand-held physique training together with one or more resistance bands according to the embodiments of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0010] The following detailed description illustrates embodiments of the present disclosure and ways in which they can be implemented.

[0011] In an aspect, an embodiment of the present dis-

closure provides a hand-held physique training device, the hand-held physique training device comprises a tubular handle comprising a first end, a second end, an inner space between the first end and the second end adapted to accommodate one or more resistance bands, a first force measurement means at the first end and a second force measurement means at the second end, and a first computing means connected to the first force measurement means and to the second force measurement means. In another aspect, an embodiment of the present disclosure provides a physique training kit comprising one or more hand-held physique training devices according to the embodiments of the present disclosure together with one or more resistance bands. The hand-held physique training device may be configured to communicate with the second computing means.

[0012] The first computing means may be accommodated at the first end of the tubular handle, at the second end of the tubular handle or in the inner space between the first end and the second. The first force measurement means at the first end the second force measurement means at the second end are connected by a cable crossing through the tubular handle. The measurement data is delivered wirelessly at least to the first computing means or alternatively to the second computing means (e.g., to a mobile device comprising a software application for further analytics and visualizations, the mobile device can be simultaneously read data from one or more hand-held physique training devices) or to the first computing means and optionally to the second computing means. The first computing means may be a microcontroller or other similar type of computer on a printed circuit board, System-on-a-chip (SoC) type of integrated circuit, field-programmable gate array (FPGA), digital signal processor (DSP), or an application-specific integrated circuits (ASIC) which is configured to receive measurement data from one or more measurement means, to process and analyze the received measurement data and optionally to communicate with one or more external devices. The shape of the first computing means is adapted suitable for fitting into the first end or into the second end of tubular handle or into the inner space of the tubular handle.

[0013] The inner space between the first end and the second end adapted to accommodate one or more resistance bands is more specifically adapted so that it can accommodate a single resistance band alone, a single resistance band wrapped two or more times into the inner space to increase a resistive load or two or more resistance bands are accommodated into the inner space to increase the resistive load.

[0014] The inner space between the first end and the second end is adapted to accommodate the one or more resistance bands so that the one or more resistance bands when received in the inner space of the tubular handle is placed along the longitudinal axis of the tubular handle through the inner space and the parts of the one or more resistance bands reaching out from the first end of the tubular handle and from the second end of the tubular handle lean onto the first force measurement means at the first end and onto the second force measurement means at the second end.

[0015] The tubular handle in combination with the first force measurement means, the second force measurement means and the first computing means enable to distribute the pressure and force exerted by the one or more resistance bands evenly during training. Such arrangement of the first force measurement means at the first end of the tubular handle and the second force measurement means at the second end of the tubular handle enables accurately to measure the resistive load and repetitions of the exercises of the user when the user uses different resistance bands alone by replacing or changing different resistance bands, multiple resistance bands with same or different characteristics simultaneously or single resistance band being wrapped multiple times to increase the resistive load. The first end of the tubular handle and the second end of the tubular handle may comprise covers to protect the first force measurement means at the first end and the second force measurement means at the second end.

[0016] The hand-held physique training device according to the embodiments of the present disclosure enables to do with resistance a very wide range of different exercises. For example, when the user is using the physique training kit comprising one or more hand-held physique training devices according to the embodiments of the present disclosure together with one or more resistance bands it is possible to train chest, back, shoulders, biceps, triceps, legs and exercise with loads corresponding up to 180 kilograms. The present hand-held physique training device enables to replace both, the resistance band and dumbbell exercises and the resistance band and bar exercises when two hand-held physique training devices are used at the same time. When two hand-held physique training devices are used at the same time a support bar through the inner space of the tubular handles may be added for a greater stability. The one or more resistance bands may be a circular resistance band.

[0017] In some embodiments, the first end may comprise a first sudden enlargement portion and the second end comprises a second sudden enlargement portion. The first sudden enlargement portion and the second sudden enlargement portion provide more space for the hand-held physique training device and enable to accommodate the first force measurement means at the first end and a second force measurement means at the second end and the first computing means more efficiently. Additionally, the sudden enlargement portion at the first end and at the second end of the tubular handle provide more structural strength to the hand-held physique training device or may comprise additional reinforcing sheets for a greater stiffness. The sudden enlargement portions may be shaped from a side view as e.g., tetragon or hexagon. Such shape helps to support the hand-held phy-

sique training device on an even, flat surface. In some embodiments, wherein the present hand-held physique training device may be equipped with a battery and needs charging, such tetragonal or hexagonal shape provides more stability when the hand-held physique training device is placed on the surface for charging to avoid moving of the device. The tetragonal or hexagonal shape is also useful for certain type of exercises when the hand-held physique training device needs to be supported to the floor or other surface.

[0018] According to the embodiments, the first force measurement means and the second force measurement means each comprise a ring-shaped force measuring sensor mounted to the inner surface of the tubular handle, a ring-shaped force distribution gasket placed onto the ring-shaped force measuring sensor, and a ring-shaped compression ring placed onto the ring-shaped force distribution gasket. The ring-shaped force measuring sensors, the ring-shaped force distribution gaskets and the ring-shaped compression rings may have opened ring shape or closed ring shape.

[0019] The one or more resistance bands apply force to the ring-shaped compression ring at random angles and pressure areas. The ring-shaped compression ring is adapted to apply pre-load to the ring-shaped force measuring sensor and when the one or more resistance bands apply force to the ring-shaped compression ring then to distribute the load towards the ring-shaped force distribution gasket. The pre-load applied by the compression ring enables to eliminate possible slack and free movement between the force measurement sensor and the inner wall of the tubular handle thus guaranteeing the precise measurement results. The compression ring may be arranged to apply constant pre-load. The ring-shaped force distribution gasket is compressed under the load applied by the one or more resistance bands (including assembly pre-load without any external load) and is arranged to distribute the load even more evenly, to act as a cushion and shock absorber to even out force deviation noise and to reduce the mechanical wear to sensor in case just the ring-shaped compression ring would apply force to the ring-shaped force measuring sensor. The force is delivered to the active area of the ring-shaped force measuring sensor.

[0020] The ring-shaped force measuring sensors are sensors, which change their resistance in response to a force applied by the one or more resistance bands. The ring-shaped force measuring sensors enable to measure force, pressure, and weight in the hand-held physique training device. For accurate measurements the ring-shaped force measuring sensor may have active area and passive area, in such case the ring-shaped force distribution gasket is placed onto the active area of the ring-shaped force measuring sensor. The ring-shaped force distribution gaskets may be narrower than the ring-shaped compression rings. The ring-shaped shape helps to eliminate slack, i.e., the space between the sensors and handle that allows movement, thus enables to improve the accuracy of the measurements.

[0021] The active area on the surface of the ring-shaped force measuring sensor is the area where applying force changes the sensor resistance value and non-active area on the surface of the ring-shaped force measuring sensor is the area where applying force does not change the sensor resistance value areas on the surface. The non-active area is typically at the edges of the ring-shaped force measuring sensor due to the manufacturing process. The ring-shaped force distribution gasket is arranged to apply the load at the active area on the surface of ring-shaped force measuring sensor to improve the measurement accuracy and repeatability.

[0022] When the user is doing exercises, the loads expressed by the one or more resistance bands to the force measuring sensors at the first end and at the second depend on an angle and placement of the one or more resistance bands inside the inner space of the tubular handle and thus may cause uneven distribution of the loads and therefore inaccurate measurement results. The arrangement of the ring-shaped force measuring sensors, the ring-shaped force distribution gaskets and the ring-shaped compression rings at the first end of the tubular handle and at the second end of the tubular handle according to the present disclosure enables to deliver and distribute the load introduced by the one or more resistance bands to the ring-shaped force measuring sensors evenly and thereby to improve the accuracy of the measurements.

[0023] Due to the possibility of uneven placement of the one or more resistance bands into the tubular handle of the hand-held physique training device, a load distribution solution is needed to deliver the force applied by the one or more resistance bands to the ring-shaped force measuring sensor. The load distribution is achieved by the combination of the ring-shaped compression ring, the ring-shaped force distribution gasket and the ring-shaped force measuring sensor of the force measurement means.

[0024] When one or more resistance bands apply force to the ring-shaped compression ring at random angle and pressure area the ring-shaped compression ring is arranged to distribute the load towards the ring-shaped force distribution gasket in a distributed way. The ring-shaped force distribution gasket is arranged to be compressed under the load (including assembly pre-load without any external load) and thereby adapted to distribute the load even more evenly, to act as a cushion shock absorber to even out small force deviation noise, to reduce the mechanical wear to ring-shaped force measuring sensor in case just the ring-shaped compression ring would apply force to the ring-shaped force measuring sensor. Thereby, the force is delivered to the active area of the ring-shaped force measuring sensor.

[0025] According to the embodiments of the present disclosure, the ring-shaped force measuring sensors at both ends of the tubular handle may be Force Resistive Sensor (FSR) type sensors, on which the resistor, which

changes when force is applied, is processed with a known resistance reference value by the first computing means. According to the embodiments the force vs resistance curve measured by the first force measurement means and second force measurement means is exponential. Therefore, the ring-shaped compression ring (pre-load applied by the compression ring) and correct reference resistance values are crucial to operate with suitable measurements range over the time. The reference resistor can be a digital potentiometer with software-controlled resistance or a precision resistor with a fixed value.

[0026] Due to different possible usage scenarios and load distribution at different ends of the tubal handle of the hand-held physique training device and different possible placements of the one or more resistance bands, ring-shaped force measuring sensors of the first force measurement means at the first end and the second force measurement means at the second end allow for equalization of mechanically expressed force resulting from random placement of the one or more resistance bands in the tubular handle and create pre-pressure on the force measurement means. According to the present disclosure this is achieved by the combination of the ring-shaped compression ring, the ring-shaped force distribution gasket and the ring-shaped force measuring sensor. By measuring the load expressed by the one or more resistance bands at both ends, i.e., at the first end and at the second end of the tubular handle the first force measurement means at the first end and the second force measurement means at the second end enable to improve the accuracy. As the hand-held physique training device hosting the one or more resistance bands, which are operated at different angles, the arrangement of the first force measurement means at the first end and a second force measurement means at the second end helps to achieve repeatable force measurement results.

[0027] Optionally, the tubular handle may further comprise a longitudinal slit between the first end and the second end. In such embodiments the ring-shaped force measuring sensors, the ring-shaped force distribution gaskets and the ring-shaped compression rings may have opened ring shape. The longitudinal slit enables placing the one or more resistance bands into the inner space and through the opened part of the opened ring-shaped force measuring sensors into the force measurement means more efficiently. Alternatively, the longitudinal slit may be closable, which provides additional strength to avoid bending.

[0028] Optionally, the first end and the second end comprise a support wall of the ring-shaped compression ring. In an embodiment wherein the ring-shaped compression ring is an opened ring-shaped compression ring to enable detection of smaller loads ((< 2kg), pre-loading the opened ring-shaped force measuring sensor is needed. Also applying the pre-load during the assembly and idle state of the hand-held physique training device enables automatic calibration of the first force measurement means and the second force measurement means and reduce the need for achieving higher accuracy during production and assembly. The support walls at the first end and at the second end of the tubular handle for the ring-shaped compression ring enable to avoid slack and free movement of the compression ring before applying the force to the force measurement means.

[0029] Inserting the opened ring-shaped compression ring into the end of the tubular handle, along with the opened ring-shaped force distribution gasket and the opened ring-shaped force measuring sensor, requires applying force and deforming the compression ring, which results in the pre-load being applied to the ring-shaped force measuring sensor.

[0030] The first end the tubular handle and the second end of the tubular handle each may comprise a curved edge. At the end of the tubular handle, where the one or more resistance bands exits the curved edge is needed for the one or more resistance bands to provide stable force delivery from the ring-shaped compression ring to the ring-shaped force distribution gasket and to reduce the wear of the one or more resistance bands. The curved edge helps to increase the measurement accuracy and repeatability due to the larger contact area between one or more resistive bands and ring-shaped compression ring. The curved edge enables wear reduction by not having a sharper edge. Additionally, or alternatively the ring-shaped compression ring may comprise also a curved edge.

[0031] As the hand-held physique training device hosting the one or more resistance bands and the one or more resistance bands themselves are operated at different angles, having force measurement means comprising ring-shaped force measuring sensor, ring-shaped force distribution gasket and ring-shaped compression ring at both ends of the tubular handle of the hand-held physique training device enables to measure the load more precisely and to achieve more repeatable force measurement results. During loading and therefore deforming, the outer surface of ring-shaped compression ring slides against the inner surface of the cover of the end of the tubular handle. Thus, an average roughness of a surface of the ring-shaped compression ring against and inner surface of the cover up to 4 μm helps to prevent ring-shaped compression ring to get jammed or limit the movement.

[0032] Optionally, at least one of the first end of the tubular handle and the second end of the tubular handle comprise enforcing means. During exercises, user's hand may try to compress the hand-held physique training device especially during the higher loads. This compression may deform the hand-held physique training device and therefore provide additional load to the ring-shaped force measuring sensor, causing false and non-repetitive readings. Thus, the enforcing means, e.g., a metal enforcement sheet placed at the first end and at the second end of the tubular handle or reinforced glass fibre material of the tubular handle or both enable to mitigate this possibility.

[0033] The ring-shaped force distribution gasket may be made of a synthetic elastic polymer. The material of the ring-shaped force distribution gasket is a foamy material which has a memory effect, i.e., keeping compressed after load is removed and depending on the material could wear during repetitive loading. Such synthetic elastic polymer may be natural rubber, latex rubber, silicon rubber or nylon. Such materials return to its original shape as quickly as possible, faster than 1-1.5 seconds. The shape recovery is more efficient the smoother is the surface.

[0034] According to different embodiments, the hand-held physique training device may further comprises at least one of an accelerometer, an electrocardiogram (ECG) measuring apparatus, a bioimpedance analyzer, a feedback system, a charging means. When the hand-held physique training device is not in use it may be configured to fall into sleep mode to save the power consumption. The accelerometer enables wake the hand-held physique training device up from sleep mode when the user starts using it. The accelerometer data further enables to positioning and movement of the hand-held physique training device during exercise compared to standard training data. In addition, the accelerometer allows to analyse the effectiveness of the exercises. The accelerometer can be a 3-axis accelerometer or 6-axis accelerometer that provides a wide measurement range, a high accuracy and performance, a compact form factor, a wide measurement range, a compact design, has a low power consumption and supports multiple operating modes for low-power and high-performance applications. The ECG measuring apparatus enables to provide accurate heart rate measurements and a long and short term analysis of body reaction to training process of the user. The bioimpedance analyzer provides insights into body composition metrics such as body fat percentage and muscle mass. This information would allow individuals to better understand their overall health and fitness. The bioimpedance readings can be translated into body fat percentage from the user and enable thus long and short term analysis of body reaction to training process. The feedback may be implemented by vibrating means, which enables haptic progress feedback to the user. The feedback system of the hand-held physique training device may be configured to use data from the ECG and bioimpedance analyzer to create personalized workout plans tailored to an individual's fitness level and goals. This would allow for more effective workouts and help prevent injury. The feedback system may be configured to provide real-time feedback during workouts, adjusting the workout plan as needed to ensure that the user is exercising safely and effectively. The ability to track progress and receive real-time feedback could help users stay motivated to continue exercising and reaching their fitness goals. A charging means may be wireless charging means comprising a wireless charging coil, a wireless charging circuitry and a battery.

[0035] In another aspect, an embodiment of the present disclosure provides a method for physique training, the method comprises measuring a voltage readings of the ring-shaped force measuring sensors by a first force measurement means and by a second force measurement means of a hand-held physique training device, converting the measured voltage readings to a raw resistance values, calculating the raw resistance values to a training load values.

[0036] In some embodiments, the method comprises additionally transmitting the raw resistance values to a second computing means and calculating the transmitted raw resistance values to a training load values. In such embodiments, the second computing means may be a server, a user device, e.g., a smartphone or other mobile devices, a computer, a second microcontroller or some external computing means. Such embodiments may be e.g., needed in such cases, wherein the user for better training purposes collects the training data via a smartphone or other device, which may be adapted to collect, analyze and visualize the measured training data.

[0037] Optionally, the method further comprises monitoring changes of the training load values, determining repetitions based on the monitored changes of the training load values. Optionally, the method may further comprises calibrating the raw resistance values before calculating the raw resistance values to the training load values. The method may further comprise validating a performance of the ring-shaped force measuring sensor of the hand-held physique training device and analyzing the factors affecting the measurement values for achieving higher accuracy during production and assembly and/or for measuring separately values of both ring-shaped force measuring sensors and automatically perform calibration of ring-shaped force measuring sensors values.

[0038] In one embodiment the voltage readings of the first force measurement means and the second force measurement means connected in parallel are received at single analog-digital input of the first computing means. The received voltage readings are converted to raw resistance (ohm) values by using +Voltage and reference resistor values. The raw resistance values are transmitted via Bluetooth to one or more second computing means for calculating the raw resistance values to load (kg) values: Calculation is done using e.g., Makima (Modified Akima) interpolation or other computationally efficient interpolation that enables interpolating data points and constructing a smooth curve through those points. Sample points (known ohm vs load pairs) are known by the application software of the second computing means. Data (load, repetition etc) presentation to user: Numeric + chart presentation.

[0039] In another embodiment the voltage readings of separately connected first force measurement means and the second force measurement means are received at corresponding two separate analog-digital inputs of the first computing means. The received voltage readings are converted to raw resistance (ohm) values by using

+Voltage and reference resistor values and voltage readings at analog-digital inputs. The raw resistance values are automatically calibrated. The automatic alignment and calibration of ohm values for both force measurement means are done to compensate for production tolerance. The calibrated resistance values are transmitted to via Bluetooth to the one or more second computing means. The raw resistance values are calculated to load (kg) values: Calculation is done using e.g., Makima (Modified Akima) interpolation or other computationally efficient interpolation that enables interpolating data points and constructing a smooth curve through those points. Sample points (known ohm vs load pairs) are known by the smartphone app software. Data (load, repetition etc) presentation to user: Numeric + chart presentation.

[0040] The advantage of this embodiment is that it enables more precise analysis for different usage angles which is done by the first computing means, enables to detect separate pre-loads for separate force measurement means which reduces the demand for production and assembly accuracy. As the pre-loads for different ends of the tubular handle do not need to be matching to provide repetitive results. This embodiment further enables to perform the automatic alignment and calibration at the first computing means or at the second computing means.

[0041] In a fourth aspect, an embodiment of the present disclosure provides computer program for physique training, which comprises instructions which, when the program is executed by a computing means, cause the computing means to carry out the method according to the present disclosure. According to the embodiments of the present disclosure the first computing means of the hand-held physique training device comprises a computer program comprising instructions which are configured to perform the measurements and convert the measured voltage readings to a raw resistance values, to calculate the raw resistance values to a training load values and other calculations, manage connectivity with a one or more second computing means and perform automatic calibration based on the calculations.

[0042] The second computing means, e.g., a smartphone, may be configured to communicate with one or more hand-held physique training devices to receive the measurements and the results of the calculations of the first computing means, to calculate the raw resistance values to a training load values, to present data to the user and to communicate with the server. The server may be configured to communicate with one or more second computing means and comprise a database of the users, a database of video trainings, a user specific training and performance data and additional functionalities for performance analysis and training plan personalization. Thus, the server may be further configured to provide the user a user-specific training plans and programs based on the training measurement data of the user collected by the one or more -held physique training devices and received in the server via one or more second computing means.

[0043] In an embodiment, wherein the hand-held physique training device comprises the first computing means with Bluetooth capability, the first force measurement means and the second force measurement means, an accelerometer and the first computing means is configured to control the first force measurement means and the second force measurement means, to calculate the measurement results, to control the accelerometer and calculate the acceleration directions, to monitor the power consumption and battery level to extend battery life, to manage and indicate the status of the hand-held physique training device, to transfer data over Bluetooth connection to the one or more second computing means. The one or more second computing means enable to collect, process and analyze the data and present it for the user on a display of second computing means. The data to be transferred may comprise the measurement data and data and corresponding calculations, the accelerometer data and corresponding calculations, the power consumption data and battery level and the status of the hand-held physique training device.

[0044] Instructions of the computer program of the first computing means may comprise one or more of a repetition counting algorithm, a live analysis of training quality (e.g., are the exercises done correctly, user's progress based modification of training plan, live comparison to different users loads and repetitions, early detections and prevention of possible health risks e.g., pulse or loads too high), simultaneous data reading from one or more hand-held physique training device when the user needs to exercise for example with two hand-held physique training devices together, determining the training load levels based on raw force readings, determining the repetitions based on live changes of load levels, collecting the accelerometer data for performance analysis, live update of training progress, sum of repetitions and loads.

[0045] In an example of the embodiments according to the present disclosure, the user starts the training session by picking up the hand-held physique training device, activating the second computing means and inserting one or more resistance bands into the inner space of the tubular handle of the hand-held physique training device.

[0046] Picking up the hand-held physique training device activates the first computing means of the hand-held physique training device by means of accelerometer. Alternatively, the first computing means of the hand-held physique training device may be activated by turning it on manually. When the user has placed the one or more resistance bands into the inner space of the tubular handle of the hand-held physique training device a preload is registered at both ends of the tubular handle of the hand-held physique training device by a first compression ring of the first force measurement means at the first end of the tubular handle and by a second compression ring of the second force measurement means at the second end of the tubular handle.

[0047] If the second computing means is previously not linked with the hand-held physique training device the user performs linking of the second computing and the hand-held physique training device. For linking the hand-held physique training device with the second computing means, corresponding unique identifiers can be used, e.g., MAC addresses, Universally Unique Identifiers (UUIDs), serial numbers, Bluetooth Device Addresses, QR Codes, NFC Tags or other identifiers can be used. Alternatively, two or more hand-held physique training devices can be linked to the one or more second computing means. If the second computing and the hand-held physique training device are paired the user starts performing the exercise using the hand-held physique training device. The one or more resistance bands is inserted into the inner space so that it forms a stretchable loop.

[0048] For starting the exercise, the user attaches or fixes the stretchable loop to or around an anchor point. The anchor point is the point relative to which the user stretches the one or more resistance bands. The anchor point may be some part of the gym equipment or a stationary object, like a door, a pole, or a heavy piece of furniture, or it can be a part of the user's body, like user's feet or hands. The anchor point may be defined by standing with one or two legs on the one part of the stretchable loop of the one or more resistance bands. In such case the anchor point is the contact point where the user's feet are in contact with the one or more resistance bands. I.e., the user's feet are creating the necessary tension and resistance for the exercise by pressing the one or more resistance bands in opposite direction to the pulling direction, effectively anchoring it in place.

[0049] Depending on the exercises and how the user holds and moves the hand-held physique training device the one or more resistance band may apply different force to the first force measurement means at the first end and to the second force measurement means at the second end of the tubular handle. E.g., during some exercises the hand-held physique training device is pulled away from the anchor point in such direction that when stretching the one or more resistance bands the one or more resistance bands is elongated equally at both sides and thus the first force applied to the first force measurement means and the second force applied to the second force measurement means by the elongated one or more resistance bands is equal.

[0050] In some other exercises when the one or more resistance bands is hold at an angle and one side of the one or more resistance bands is elongated more than the other side of the one or more resistance bands then the side which is elongated more applies higher force to the force measurement means than the side which is elongated less. Thus, an average raw resistance value of the first force measurement means and the second force measurement means is calculated by following formula: R1(average) = (R1(first) x R1(second)) / (R1(first) + R1(second)), wherein R1(first) is the first raw resistance value of the first force measurement means and R1(second) is the second raw resistance value of the second force measurement means.

[0051] When user starts performing the exercise the user stretches the one or more resistance bands in relation to the anchor point by pulling the hand-held physique training device away from the anchor point. This way the user elongates the one or more resistance bands, the elongated one or more resistance bands applies a force to the first force measuring sensor of the first force measurement means at the first end of the tubular handle and to the second force measuring sensor of the second force measurement means at the second end of the tubular handle. When the first computing means is activated, it is configured to periodically to receive the force readings applied to the first force measurement means and to the second force measurement means. The first computing means is then configured to periodically to calculate the received voltage readings to the raw resistance values.

[0052] The calculated raw resistance values are calculated to the training load values. Calculating the raw resistance values to the training load values may be performed directly by the first computing means. In such embodiments the hand-held physique training device may comprise a display wherein the training load values are displayed to the user or the calculated training values may be sent from the first computing means of the hand-held physique training device to the second computing means (e.g., a smartphone, a computer, a server) for storing the calculated training values or displaying the calculated training values to the user.

[0053] Alternatively, the calculated raw resistance values may be sent from the first computing means to the second computing means and in such embodiments the second computing means is configured to calculate the raw resistance values to the training load values. The data packages comprising the calculated raw resistance values and optionally acceleration data and battery level data may be transferred from the first computing means to the second computing means by advertising data packages over Bluetooth. The time intervals may be in the range of 20-10240 milliseconds, typically 100 milliseconds.

[0054] Converting the measured voltage readings to the raw resistance values is performed by the first computing means. The first computing means is configured to receive a center voltage as Analog-Digital input from a voltage divider formed of a pair of ring-shaped force measuring sensors (R1) and a precision resistor (R2) for reference value. The pair of ring-shaped force measuring sensors comprises the first ring-shaped force measuring sensor of the first force measurement means and the second ring-shaped force measuring sensor of the second force measurement means. Optionally the first computing means may be configured to receive battery level reading or accelerometer data.

[0055] The first computing means is further configured collect sample voltage values (V) from the voltage divid-

er, calculate the average value of the sample voltage values (V(out)) and by using the calculated average value of the sample voltage values (V(out)) to calculate a variable value R1 (Average of 2 force resistive sensors), i.e., the raw resistance value, by using the following formula. R1=(R2/(V(out))*V(in)-R2, wherein R1 is variable value of pair of ring-shaped force measuring sensors (i.e., the raw resistance values), R2 is precision resistor value, V(in) is voltage input to voltage divider. As the ring-shaped force measuring sensors are constantly loaded by the ring-shaped compression ring, the R1 values are constantly available regardless of usage of the ring-shaped force measuring sensors of the hand-held physique training device.

[0056] For calculating the raw resistance values in ohms to the training load values in kilograms the corresponding computing means is configured to use a set of reference data comprising previously known sample points of resistance vs kilograms and an interpolation (e.g., Modified Akima (Makima) or other computationally efficient interpolation that enables interpolating data points and constructing a smooth curve through those points) to fill the gaps between sample points. The sample points may be predefined based on the experiments of can be automatically detected based on the preload resistance values.

[0057] The corresponding computing means is further configured to analyse changes of force applies and based on the analysis count the repetitions of the exercises and exercise performance. The analysis comprises detecting the start and detecting the end of the exercise repetition. Start of the new repetition is detected when a sudden increase of the force is detected. Completion of the exercise repetition is detected when a sudden decrease of the force is detected. The maximum value between the detected sudden increase of the force and the detected sudden decrease of the force enables then to receive the maximum load in kilograms experienced during the exercise, which is displayed to the user.

DETAILED DESCRIPTION OF THE DRAWINGS

[0058] Referring to Fig. 1 where is shown a front section view of a hand-held physique training device **100** according to an embodiment of the present disclosure. The hand-held physique training device **100** comprises a tubular handle **102** comprising a first end **104,** a second end **106,** an inner space **108** between the first end and the second end adapted to accommodate one or more resistance bands **130,** a first force measurement means **110** at the first end and a second force measurement means **120** at the second end, and a first computing means **140** connected to the first force measurement means and to the second force measurement means. The first force measurement means **110** comprises a first ring-shaped force measuring sensor **112** mounted to the inner surface of the first end of the tubular handle, a first ring-shaped force distribution gasket **114** placed onto the first ring-shaped force measuring sensor, and a first ring-shaped compression ring **116** placed onto the first ring-shaped force distribution gasket. The second force measurement means **120** comprises a second ring-shaped force measuring sensor **122** mounted to the inner surface of the second end of tubular handle, a second ring-shaped force distribution gasket **124** placed onto the second ring-shaped force measuring sensor, and a second ring-shaped compression ring **126** placed onto the second ring-shaped force distribution gasket. The first end of the tubular handle and the second end of the tubular handle each comprise a curved edge **118, 128.** The one or more resistance bands **130** is attached to the anchor point **133.** Force vectors applying at the compression ring by the one or more resistance bands during the exercise when the hand-held physique training device **100** is pulled away from the anchor point **133** and the one or more resistance bands is elongated are shown by arrows **131** and **132.** In such an example, the anchor point **133** is formed by the user's leg when the part of one or more resistance bands is supported on the ground **134** and the user has stepped to the one or more resistance bands. Alternatively, the anchor point **133** may be a hook on the wall **134.** When the one or more resistance bands **130** is pulled away from the anchor point **133,** both sides **135** and **136** of the one or more resistance bands are elongated equally. Thus, the force applied to the first force measurement means **110** at the first end and the second force measurement means **120** at the second end is equal.

[0059] Referring to figures Fig. 2 there is illustrated a front section view of a hand-held physique training device **200** according to a second embodiment of the present disclosure. The hand-held physique training device **200** shown in figures Fig. 2a comprises a tubular handle **202** comprising a first end **204,** a second end **206,** an inner space **208** between the first end and the second end adapted to accommodate one or more resistance bands **230,** a first force measurement means **210** at the first end and a second force measurement means **220** at the second end, and a first computing means **240** connected to the first force measurement means and to the second force measurement means. The first end **204** comprises a first sudden enlargement portion **205** and the second end **206** comprises a second sudden enlargement portion **207.** The first force measurement means **210** comprises a first ring-shaped force measuring sensor **212** mounted to the inner surface of the first end of the tubular handle, a first ring-shaped force distribution gasket **214** placed onto the first ring-shaped force measuring sensor, and a first ring-shaped compression ring **216** placed onto the first ring-shaped force distribution gasket. The second force measurement means **220** comprises a second ring-shaped force measuring sensor **222** mounted to the inner surface of the second end of tubular handle, a second ring-shaped force distribution gasket **224** placed onto the second ring-shaped force measuring sensor, and a second ring-shaped compression ring **226** placed onto

the second ring-shaped force distribution gasket. The first end of the tubular handle and the second end of the tubular handle each comprise a curved edge **218, 228.** In different positions of the hand-held physique training device the different directions of the force vectors applying at the ring-shaped compression ring by the one or more resistance bands during exercising are shown by arrows **260.**

[0060] The one or more resistance bands **230** is attached around the anchor point **233.** Force vectors applying at the compression ring by resistance band during elongation exercise are shown by arrows **231** and **232.** Different directions of the force vector applying at the ring-shaped compression ring by the one or more resistance bands during exercising. In this example, the anchor point **233** is formed so that the one or more resistance bands is supported around a post **234.** The post **234** may be a part of the gym equipment, a stationary object or furniture. When the one or more resistance bands **230** is pulled away from the anchor point **233,** the sides **235** and **236** of the one or more resistance bands are stretched and elongated unequally. Thus, the side **236,** which is stretched and elongated more applies more force to the second force measurement means **220** at the second end than the less stretched and elongated side **235** to the first force measurement means **210** at the first end. I.e., stretching and elongating one side of the one or more resistance bands more than the other side means applying more force at the corresponding force measurement means. Thus, the applied force at the first force measurement means **210** at the first end and the force applied at the second force measurement means **220** at the second end are unequal.

[0061] Fig. 3 is a side view of the embodiment of the hand-held physique training device shown in figure Fig. 2 at first end illustrating the layers of ring-shaped sensors of the force measurement means accommodated into the sudden enlargement portion **305** at the end of the tubular handle. The first sudden enlargement portion **305** at the end of the tubular handle is further adapted to accommodate the first computing means **340.** At first end the first ring-shaped force measuring sensor **312** is mounted to the inner surface of the first end of the tubular handle, a first ring-shaped force distribution gasket **314** placed onto the first ring-shaped force measuring sensor **312,** and a first ring-shaped compression ring **316** placed onto the first ring-shaped force distribution gasket **314.** In the embodiment the tubular handle comprises a longitudinal slit **303** between the first end and the second end. A support wall **380** is shown at both sides of the longitudinal slit **303.** Delivery and distribution of the load applied by the one or more resistance bands **330** placed into the inner space 308 of the tubular handle to the force measurement means according to the embodiments of the present disclosure is illustrated as follows. The one or more resistance bands **330** apply force to the ring-shaped compression ring **316** at random angles and pressure area. The ring-shaped compression **316** ring is adapted to distribute the load towards the ring-shaped force distribution gasket **314.** The ring-shaped force distribution gasket **314** is compressed under the load and is arranged to distribute the load even more evenly. The force is delivered to the active area of the ring-shaped force measuring sensor **312.**

[0062] Referring to figures Fig. 4a-FIG. 4d there is illustrated examples of uneven placements of one or more resistance bands **430** in an inner space **408** of the tubular handle **402** of the hand-held physique training device **400** according to the embodiments of the present disclosure, wherein the one or more bands leans on the opened ring-shaped compression ring **416.** Figure Fig. 4a shows an example, wherein only edges of the one or more bands **430** deliver the load to the opened ring-shaped compression ring **416.** Figure Fig. 4b shows an example, wherein the one or more resistance bands **430** somewhat follows the curvature of the opened ring-shaped compression ring **416.** Mainly the edges of the one or more resistance bands **430** deliver the load to the opened ring-shaped compression ring **416.** Figure Fig. 4c shows an example, wherein only the one or more resistance bands **430** follows the curvature the opened ring-shaped compression ring **416.** Full surface of the one or more resistance bands **430** delivers the load to opened ring-shaped compression ring **416.** Figure Fig. 4d shows an example, wherein multiple resistance bands **430** follow the curvature of the opened ring-shaped compression ring **416.** Edges or full surface of the multiple resistance bands **430** deliver the load to the opened ring-shaped compression ring **416.**

[0063] Referring to the figures Fig. 5a and Fig. 5b there is shown circuit diagrams according to the embodiments of the present disclosure. Figure Fig. 5a shows the circuit diagram of the first force measurement means **510** at the first end of the tubular handle and the second force measurement means **520** at the second end of the tubular handle connected in parallel to the first computing means to compensate for different usage angles. The measurement readings and corresponding precision resistor **570** reference values are received at single analog-digital input of the first computing means **540,** which is connected over Bluetooth to a second computing means **542.** Figure Fig. 5b shows the circuit diagram of the second embodiment wherein the first force measurement means **510** at the first end of the tubular handle and the second force measurement means **520** at the second end of the tubular handle are connected separately to the first computing means **540** through the separate analog-digital inputs. The measurement readings and corresponding precision resistor **570a, 570b** reference values are received at single analog-digital input of the first computing means **540,** which is connected over Bluetooth to a second computing means **542.**

[0064] Referring to Fig. 6 a physique training kit with a block diagram of electronic components and a method for physique training according to an embodiment of the present disclosure is illustrated. A user **690** is exercising with two hand-held physique training devices **600a** and

600b using a resistance bands **630.** The two hand-held physique training devices **600a** and **600b** are linked over Bluetooth with a second computing device being connected via Wifi to a server **650.** The two hand-held physique training devices **600a** and **600b** have same configuration. The configuration first hand-held physique training device **600a** and the configuration of the second hand-held physique training device **600b** both comprise the first force measurement means **610** and the second force measurement means **620** connected to a Bluetooth enabled first computing means **640.** The configuration according to the embodiment further comprises a Bluetooth antenna **664,** a LED signals **666,** a charging module **662** and an accelerometer **668** connected to the first computing means **640.** The anchor point **633** is formed so that the user is standing on the part of one or more resistance bands supported to the ground **634** and the user has stepped to the one or more resistance bands.

[0065] Referring to figures Fig. 7a-Fig.7e, examples of the force applied by different resistance bands to the first force measurement means and to the second force measurement means when the one or more resistance bands is stretched and elongated by a user by pulling the hand-held physique training device away from the anchor point. On figure Fig. 7a a user **790** is exercising with one hand-held physique training device **700** with a circular resistance band **730** placed through the tubular handle of the hand-held physique training device **700** and attached to an anchor point **733.** The user by pulling the hand-held physique training device away from the anchor point **733** is stretching and elongating the circular resistance band so that both sides **735** and **736** of the circular resistance band are stretched and elongated equally and thus the force applied by the circular resistance band to the first force measurement means **R1ex4** and to the second force measurement means **R2ex4** are equal.

[0066] On figure Fig. 7b a user **790** is exercising with one hand-held physique training device **700** with a circular resistance band **730** placed through the tubular handle of the hand-held physique training device **700** and attached to an anchor point **733.** The user by pulling the hand-held physique training device away from the anchor point **733** is stretching and elongating the circular resistance band so that the sides **735** and **736** of the circular resistance band are stretched and elongated unequally and thus the force applied by the circular resistance band to the first force measurement means **R1ex5** and to the second force measurement means **R2ex5** are not equal. In this example one side **736** is elongated more than the other side **735** of the circular resistance band, thus the side **736** is elongated more applies more force to the second force measurement means. Thus, an average raw resistance value of the first force measurement means and the second force measurement means is calculated by following formula: R1average=(R1ex5 x R2ex5)/(R1ex5 + R1R2ex5), wherein **R1ex5** is the first raw resistance value of the first force measurement means and **R2ex5** is the second raw resistance value of the second force measurement means.

[0067] On figures Fig. 7c-Fig. 7e a user **790** is exercising with two hand-held physique training devices **700a** and **700b** with a circular resistance band **730** placed through the tubular handle of both hand-held physique training devices **700a** and **700b** and attached to an anchor point **733.** The user by pulling both hand-held physique training devices **700a** and **700b** away from the anchor point **733** is stretching and elongating the circular resistance band so that the sides **735** and **736** of the circular resistance band are stretched and elongated equally and due to using two hand-held physique training devices the forces applied by the circular resistance band to the force measurement means of both hand-held physique training devices are different. I.e., force **R1ex1** applied to the first force measurement means of the first hand-held physique training device and the force **R4ex1** applied the second force measurement means of the second hand-held physique training device are higher than the force **R2ex1** applied to the first force measurement means of the first hand-held physique training device and the force **R3ex1** applied the second force measurement means of the second hand-held physique training device. Thus, an average raw resistance values of the first force measurement means and the second force measurement means is calculated for both hand-held physique training devices by following formulas: R1average1=(R1ex1 x R2ex1)/(R1ex1 + R2ex1) and R1average2=(R3ex1 x R4ex1)/(R3ex1 + R4ex1), wherein **R1ex1** and **R3ex1** the first raw resistance value of the first force measurement means of one hand-held physique training device **700a** and second hand-held physique training device **700b** and **R2ex1** and **R4ex1** the second raw resistance value of the second force measurement means of one hand-held physique training device **700a** and second hand-held physique training device **700b.**

[0068] Figures Fig. 7c-Fig. 7e further illustrate usage of different type of resistance bands. On figure Fig. 7d the resistance band has the same thickness as the resistance band in the example of Fig. 7c but is worn out. The elongation of such resistance band is the same as the elongation of the resistance band of the example in Fig. 7c, but detected resistances and forces are lower due to the fact that the resistance band is worn out and provides less resistance during elongation. This can be analyzed by the computing means and indicate to the user that the resistance band is getting worn out over time. In figure Fig. 7e the resistance band has the smaller thickness than the thickness of resistance band in the example of Fig. 7c, the elongation of resistance is the same as the elongation of the resistance band in the example of Fig. 7c, but detected resistances and forces are lower since the resistance band provides less resistance during elongation. The computing means is configured to determine that during the same exercise less force is applied and the system understands that therefore other band is used.

Claims

1. A hand-held physique training device (100, 200, 400, 600a, 600b, 700, 700a, 700b), the hand-held physique training device comprises

   a tubular handle (102, 202) comprising
   a first end (104, 204),
   a second end (106, 206),
   an inner space (108, 208, 308, 408) between the first end and the second end adapted to accommodate one or more resistance bands (130, 230, 330, 430, 630, 730),
   a first force measurement means (110, 210, 510, 610) at the first end and a second force measurement means (120, 220, 520, 520, 620) at the second end, and
   a first computing means (140, 240, 340, 540, 640) connected to the first force measurement means and to the second force measurement means.

2. The hand-held physique training device according to claim 1, wherein the first end (204) comprises a first sudden enlargement portion (205) and the second end (206) comprises a second sudden enlargement portion (207).

3. The hand-held physique training device according to claim 1 or 2, wherein the first force measurement means (110, 210, 510, 610) and the second force measurement means (120, 220, 520, 520, 620) each comprise

   a ring-shaped force measuring sensor (112, 212, 312, 122, 222) mounted to the inner surface of the tubular handle,
   a ring-shaped force distribution gasket (114, 214, 314, 124, 224) placed onto the ring-shaped force measuring sensor, and
   a ring-shaped compression ring (116, 216, 316, 416, 126, 226) placed onto the ring-shaped force distribution gasket.

4. The hand-held physique training device according to any of preceding claims, wherein the tubular handle (202) further comprises a longitudinal slit (203) between the first end (204) and the second end (206).

5. The hand-held physique training device according to claim 4, wherein the first end of the tubular handle and the second end of the tubular handle comprise at least one support wall (380) for the ring-shaped compression ring at one or both sides of the longitudinal slit (203).

6. The hand-held physique training device according any of preceding claims, wherein the first end of the tubular handle and the second end of the tubular handle each comprise a curved edge (118, 128, 218, 228).

7. The hand-held physique training device according any of preceding claims, wherein an average roughness of a surface of the ring-shaped compression ring against an inner surface of a cover is up to 4 μm.

8. The hand-held physique training device according any of preceding claims, wherein at least one of the first end of the tubular handle and the second end of the tubular handle comprise enforcing means.

9. The hand-held physique training device according any of preceding claims, wherein the ring-shaped force distribution gasket is made of a synthetic elastic polymer.

10. The hand-held physique training device according any of preceding claims, wherein the hand-held physique training device further comprises at least one of an accelerometer, an electrocardiogram measuring apparatus, a bioimpedance analyzer, a feedback system, a charging means.

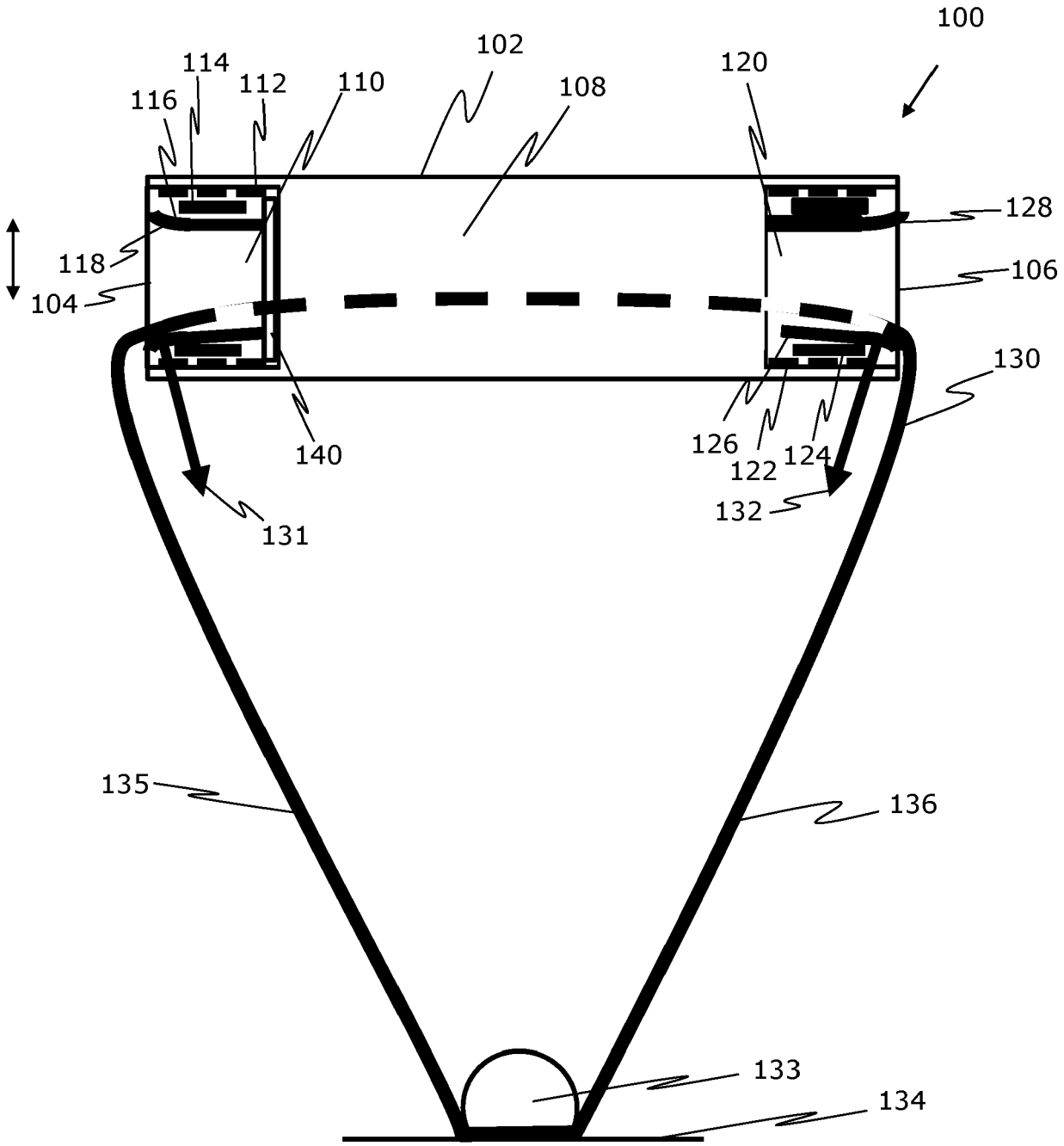
11. A method for physique training, the method comprises measuring a voltage readings of the ring-shaped force measuring sensors by a first force measurement means and by a second force measurement means of a hand-held physique training device,
    converting the measured voltage readings to a raw resistance values, calculating the raw resistance values to a training load values.

12. The method according to claim 11, wherein method further comprises monitoring changes of the training load values,
    determining repetitions based on the monitored changes of the training load values.

13. The method according to claim 11 or 12, wherein the method further comprises calibrating the raw resistance values before calculating the raw resistance values to the training load values.

14. A physique training kit comprising one or more hand-held physique training devices (700a, 700b) according to any of claims 1-10, together with one or more resistance bands (730).

15. A computer program for physique training comprising instructions which, when the program is executed by a computing means, cause the computing means to carry out the method of any one of claims 11-13.


100
102
114
112
110
108
120
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128
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106
104
130
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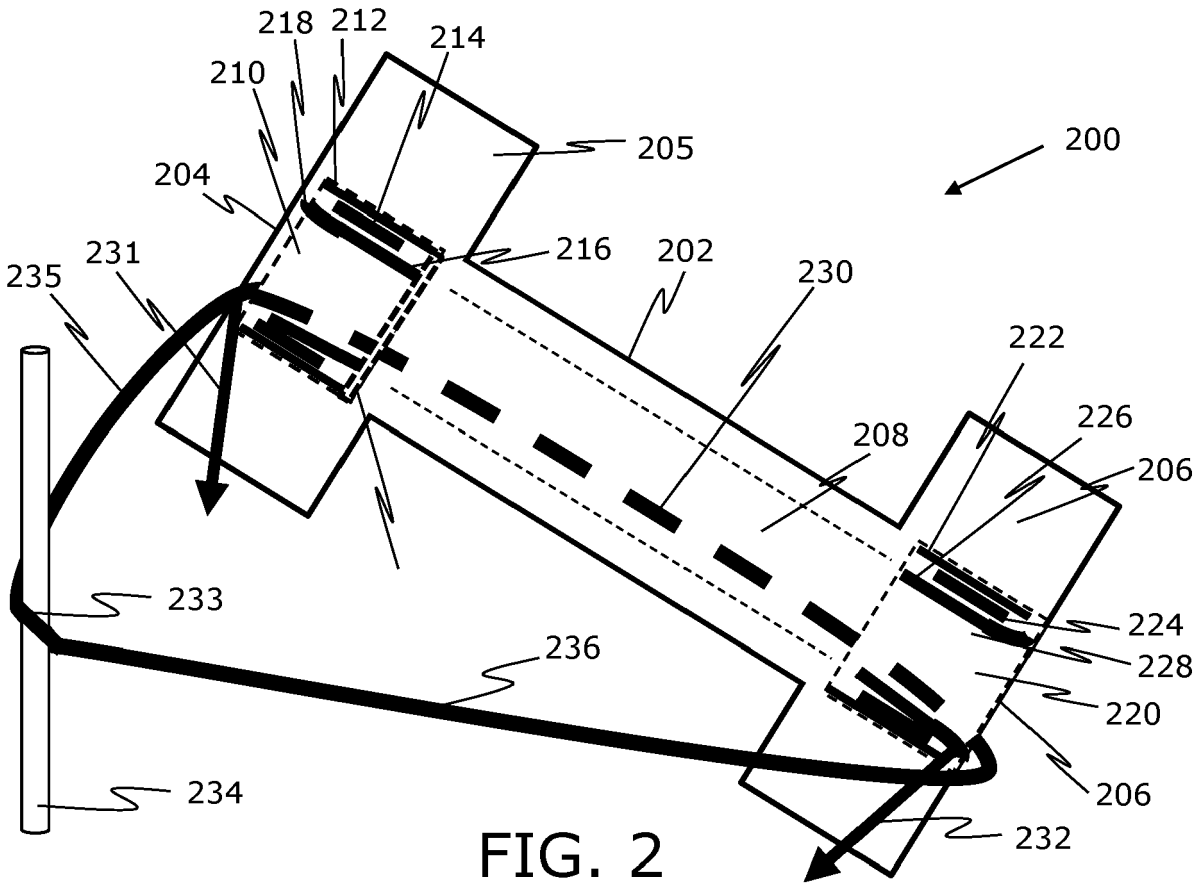
126
122
124
131
132
135
136
133
134

FIG. 1


218
212
214
210
205
200
204
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230
235
222
226
208
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233
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236
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234
232

FIG. 2

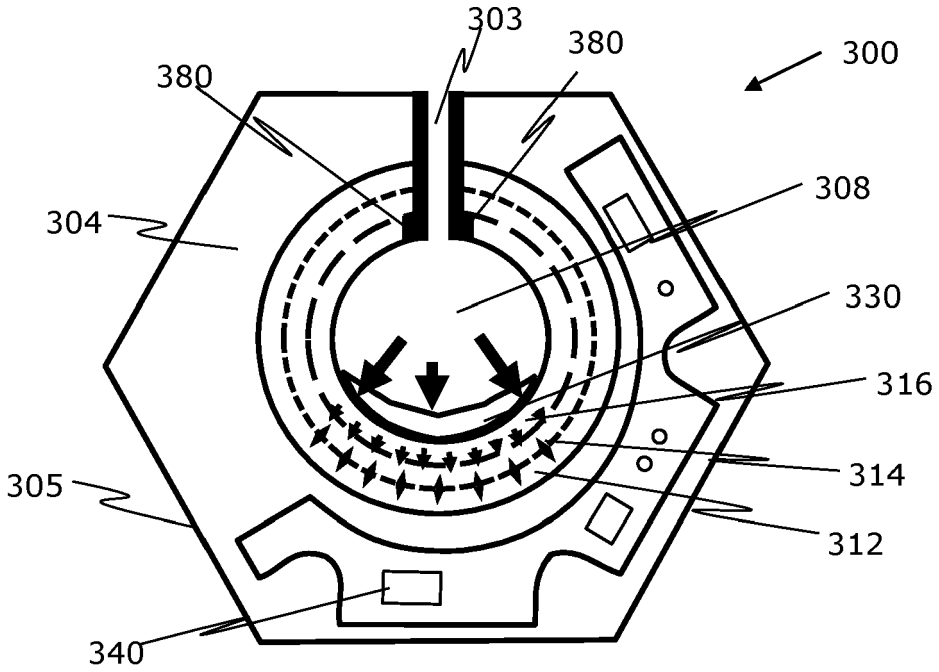
303
380
300
380
308
304
330
316
314
305
312
340

FIG. 3

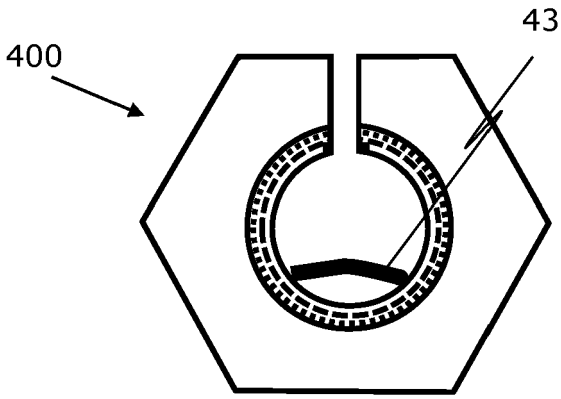

FIG. 4a

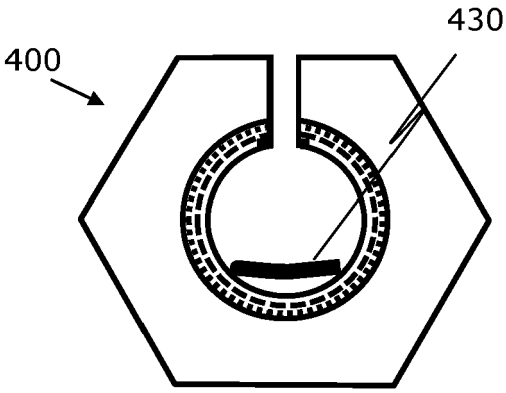

FIG. 4b

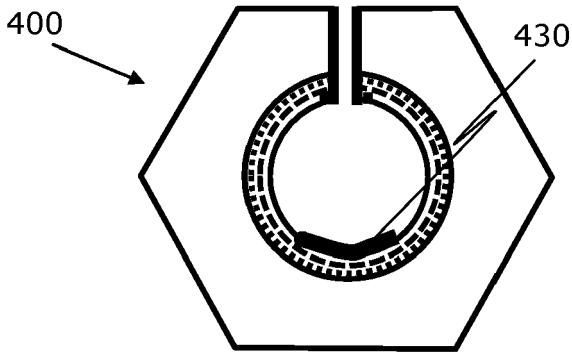

FIG. 4c

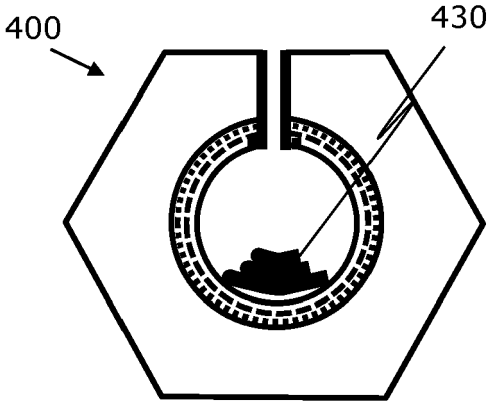

FIG. 4d

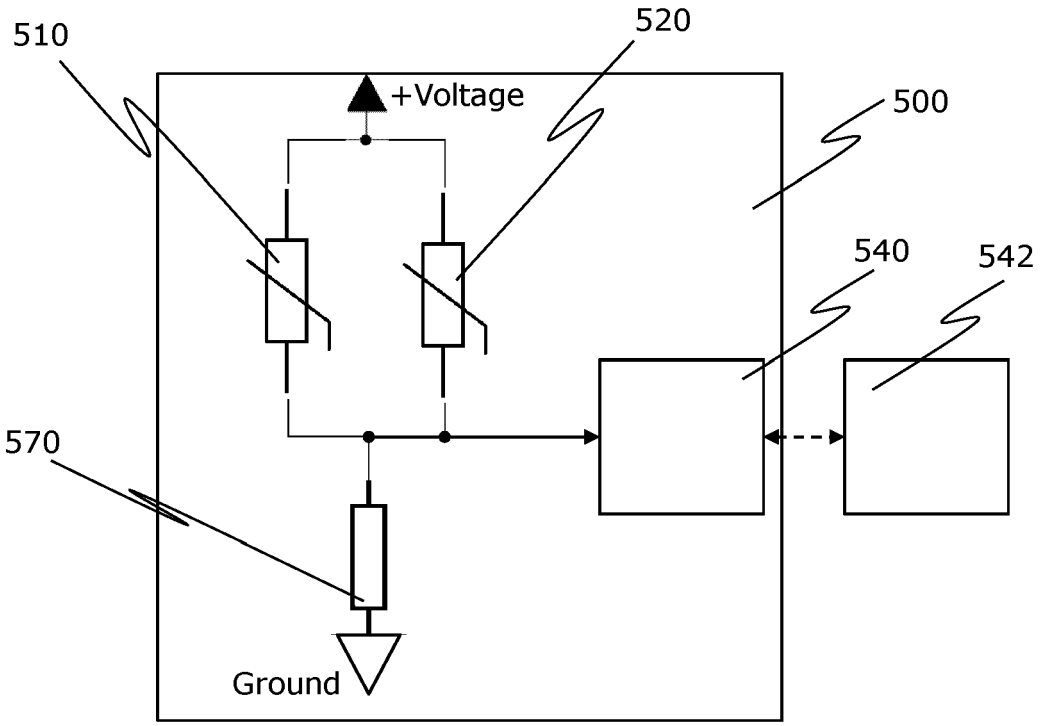
510
520
+Voltage
500
540
542
570
Ground

FIG. 5a

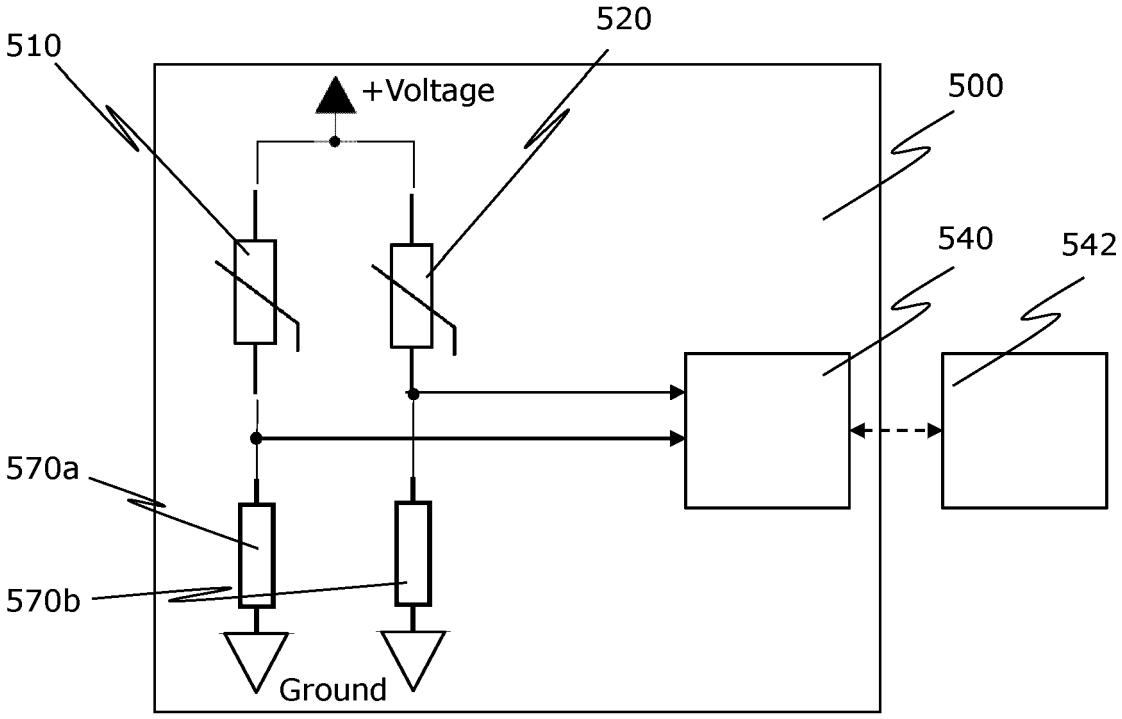
510
520
+Voltage
500
540
542
570a
570b
Ground

FIG. 5b

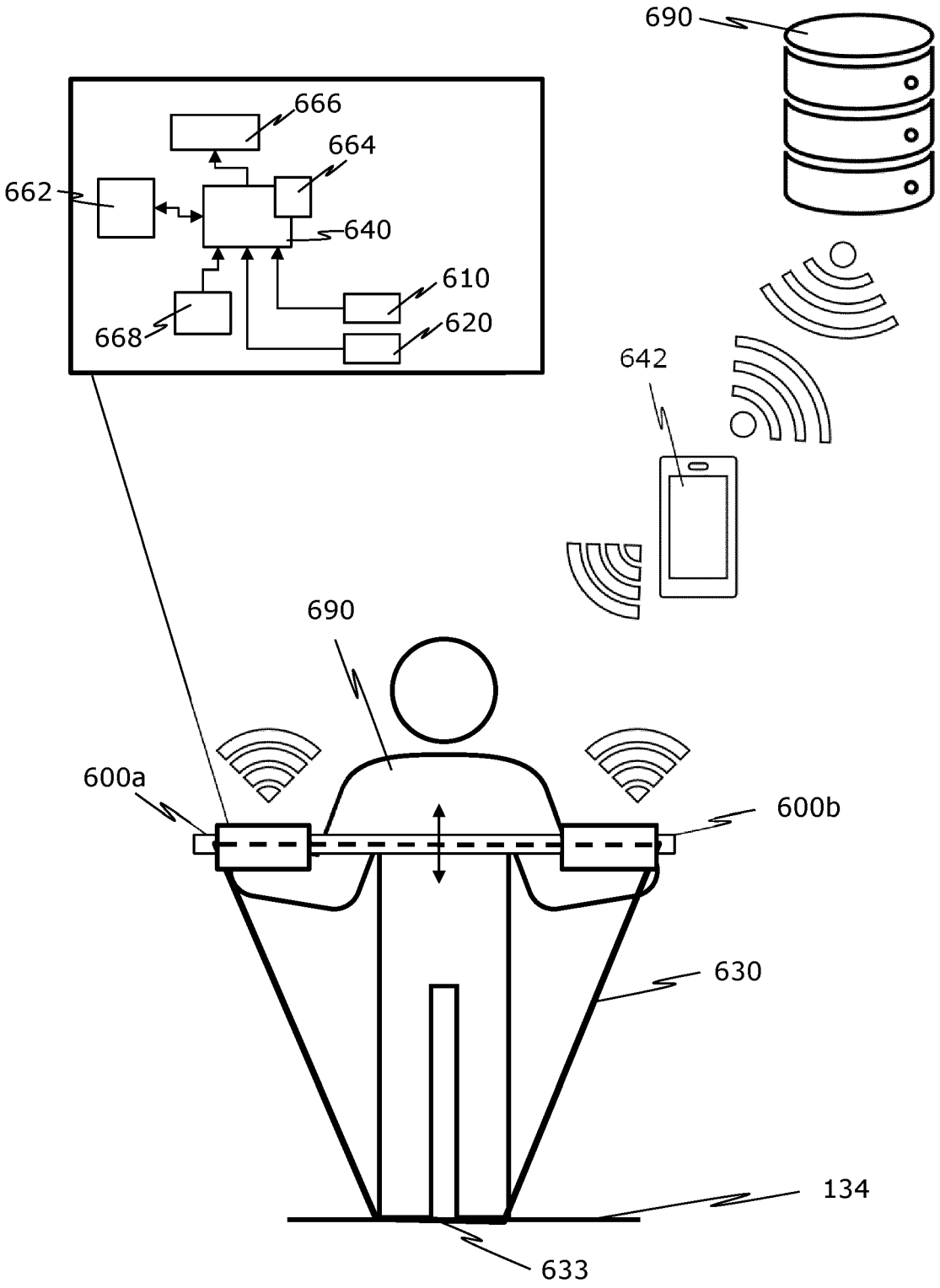

FIG. 6

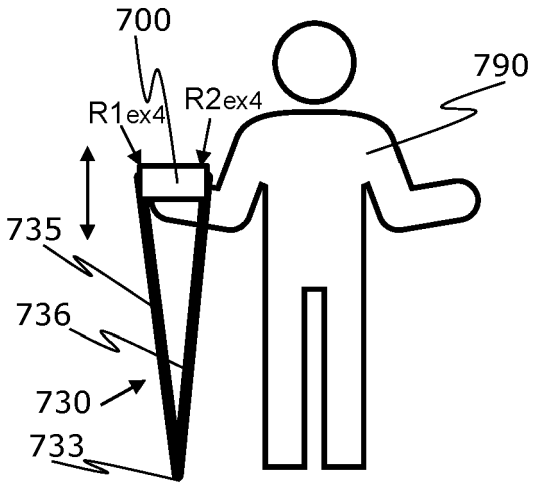

FIG. 7a

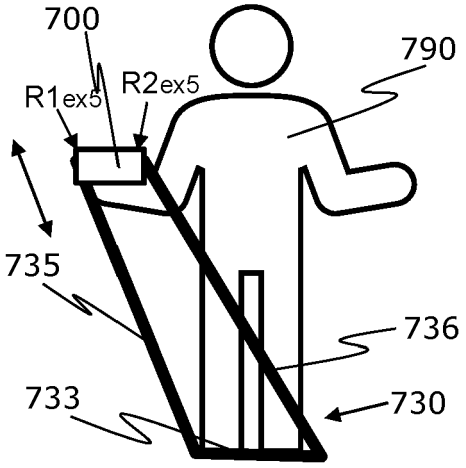

FIG. 7b

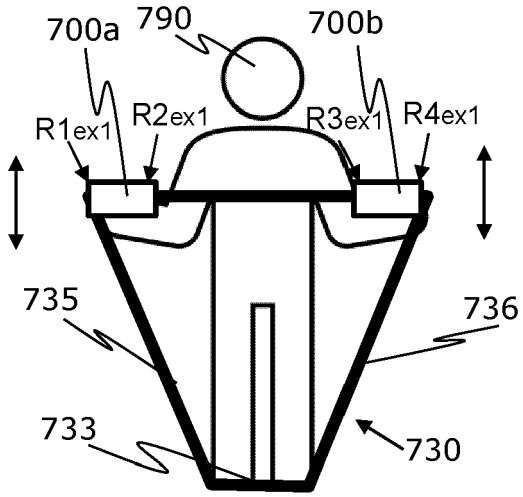

FIG. 7c

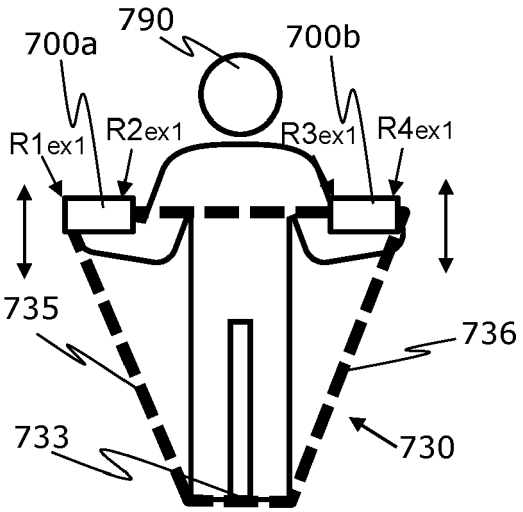

FIG. 7d

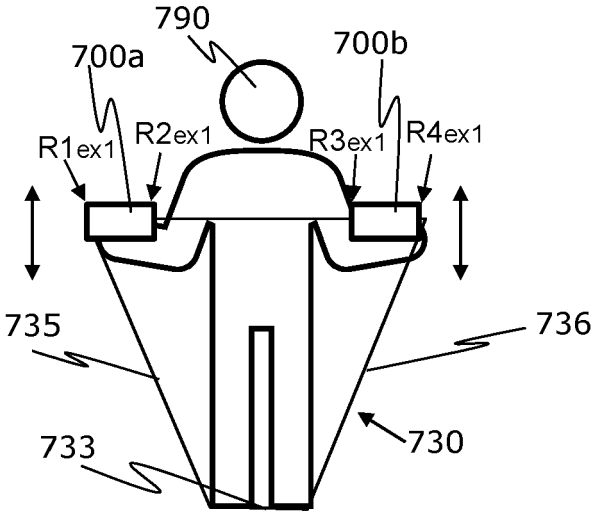

FIG. 7e

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EUROPEAN SEARCH REPORT

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Place of search	Date of completion of the search	Examiner
Munich	20 September 2023	Borrás González, E

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