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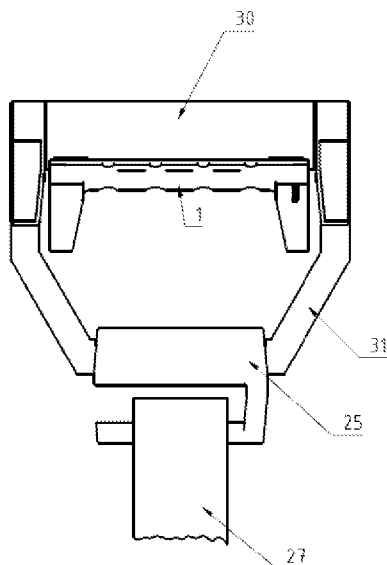


FIG. 3a

(57) Abstract: A lifting exercise monitoring hand device (1) is provided comprising a finger grip section (1) and a pairing section (3) that can comprise an oppositely arranged concave handle mating section. The device comprises at least one force sensor, a wireless data transceiver (12) and optionally also an inertial measurement unit (IMU). The finger grip section has a width fitting a human user's hand, and the force sensor is arranged to measure a weight placed on the pairing section and the device is configured to assess movement of the device and the transceiver configured to transmit data recorded by the device. The invention also provides a system comprising the hand device and associated software loadable onto a computer device with a wireless receiver such as to a smart phone or smart watch.

Lifting exercise and rehabilitation monitoring hand device

FIELD OF INVENTION

The disclosure is within the field of exercise and rehabilitation devices and specifically relates to an exercise and/or rehabilitation monitoring device that comprises a finger grip unit with an assembly of sensors, the grip fits a user's hand and grips a dumbbell or other type of conventional weightlifting equipment.

BACKGROUND

With the rapid development of sensor technology and wireless communication devices electronic monitoring of exercise has gained popularity. For example, treadmills record user activity and can be connected to pulse recording devices, and GPS based sport watches are used to record movement, speed and pulse during exercise, such as running and biking.

Electronic devices have been proposed for monitoring stationary weightlifting exercise.

US2021308524A1 discloses a strength training apparatus comprising a grip device to encircle a handlebar of a weight training piece of equipment, the grip device comprises a plurality of segments joined by flexible connecting members to encircle a handlebar, wherein each segment comprises a plurality of inwardly facing force sensors and circuitry to receive and process force information collected by the sensors. Hence, the diameter of the circle formed by the plurality of segments necessarily needs to match the diameter of the handlebar. Furthermore, the full encirclement of the training apparatus around the handlebar of a weight training piece adds substantially to the total diameter of weight training piece handle, this may cause discomfort to the user (e.g., result in hand fatigue or lack of leverage) or worse the hand-span (palm and fingers) of the user may not be sufficient to fully enclose the device encircling the handlebar. Furthermore, the correct placement and locking of the training apparatus may prove problematic for use, i.e., the centre of the cylinder-like training device needs to preferably align with the centre point of the handlebar.

WO2020027608A1 discloses a dumbbell that includes a gyroscope sensor disposed inside the handle for providing feedback indicating proper posture, where the feedback may be provided by a vibrator giving haptic vibration signals to the user.

US2019290962A1 discloses a strength training apparatus with a circular connection component comprising a force sensor for attaching to a resistance band and measure applied force to the resistance band during an exercise.

There is continued demand for improved monitoring possibilities to simplify and improve automatic monitoring of exercise.

BRIEF DESCRIPTION OF FIGURES

Fig. 1 shows a first embodiment of the device with a finger grip section and pairing section that comprises contact surfaces to mate with a weightlifting piece.

Fig. 2 shows another embodiment with a finger grip section in the form of a handle and a pairing section extending therefrom in the form of a bracket.

Fig. 3 shows a third embodiment, where a unit as described in the first embodiment cooperates with a handle and bracket unit essentially as described in the second embodiment.

Fig. 4 shows a perspective view of the device assembly from Fig. 3, joined to a resistance band.

Fig. 5 shows raw data output indicating the applied force over time during exercise with a resistance band, as measured with a built-in strain gauge.

Fig. 6 shows calculated range of motion of the same reps as in Fig. 5.

Fig. 7 shows an illustration of the hand device being used measuring a dumbbell bicep curl.

Fig. 8 shows a fourth embodiment with a finger grip section in the form of a handle and a pairing section, extending therefrom, in the form of a bracket with a hook fastening means.

Fig. 9 shows photographs of the embodiment illustrated in Fig. 8, wherein the pairing section is paired with a dumbbell (Fig. 9a), with a resistance band (Fig. 9b) and with a kettlebell (Fig. 9c).

SUMMARY

The present invention provides a new sensor and recording device for monitoring and recording weightlifting and related exercises. The device comprises a portable handheld unit (hand device) with a finger grip that fits comfortably in a user's hand as she grabs a weightlifting piece such as a dumbbell. The device pairs with the weightlifting piece or equipment that the user wishes to use for her exercise, such as a dumbbell, barbell, kettlebell or the like, and can also be used with resistance bands, bars, stands, and the like training equipment, making the device easily transferable between different exercises and different equipment. The device can be used both to record (log) exercises, and also to provide to the user feedback as to how the exercises are performed. The device is provided in different configurations, where a first configuration the device pairs with a weightlifting piece such that

the user holds the device and handle of the weightlifting piece in her hand; in this configuration it is therefore essential that the device is shaped so as not to add too much thickness to the diameter of the handle of the weightlifting piece. In other configurations the device pairs with a weightlifting piece or other equipment differently, such that the user does not hold the weightlifting piece or equipment in her hand, only a finger grip handle of the device of the invention. Also, in these configurations it is important that the device provides a comfortable grip.

Accordingly, in a first aspect the invention sets forth a lifting exercise monitoring hand device which is defined in the appended claims. The device comprises a finger grip section that mates with the user's fingers and palm and has a length and thickness accommodating a human user's hand, preferably suitably shaped and textured to provide a firm and steady fit, such as preferably by having a contact surface from a non-slippery material (rubber, silicon, leather, or the like) and also preferably comprising suitably shaped "valleys" and "ridges" to fit the grip of the fingers of the hand. The finger grip section comprising a length and thickness accommodating a human user's hand allows the user to obtain a more comfortable and secure grip around the device and the mated or connected exercise equipment. This improves both stability and control over the device and exercise equipment leading to a reduced risk of repetitive strain injuries such as discomfort, fatigue or Carpal tunnel syndrome, wherein poorly designed finger grip section may distribute pressure unevenly across the hand.

When discussing the geometry of the device, "length" refers generally to length along an axis extending along the finger grip of the device (see e.g., Fig. 1b, the axis labelled as "1c"). Length of finger grip section is thus length along the axis of the section to be gripped and held by user's hand (in Fig. 1a, 1b, 1c) this is the length of section 2, between support elements 5.

The device further comprises a pairing section for pairing with a weightlifting piece or other exercise equipment, and at least one force sensor, such as but not limited to a strain gauge, capacitive force sensor, or piezoelectric force sensor and a wireless data transmitter, wherein the at least one force sensor is arranged to measure a weight or force applied by the exercise piece/equipment which is being used and paired with the pairing section, where the device is further configured to assess movement of the device, at least in part based on output from said force sensor and the transmitter is configured to transmit data recorded by the device. The transmitter is preferably a transceiver, such that the transceiver can transmit signal and receive signals, such as control signals from an associated app in a computer device such as smart phone.

In one embodiment, the pairing section is configured adjacent and parallel to the finger grip section and shaped to mate with a handle of a weightlifting piece, such that a user can grab

and hold the device and the mating piece in his hand. In this embodiment the pairing section may comprise at least one contact surface arranged oppositely the finger grip section, where the contact surface preferably has a concave curvature to mate with a conventional substantially cylindrical handle of a weightlifting piece. The concave curvature may have a radius in the range of 10 to 25 mm and an angle in the range from 30 to 180°, preferably in the range 45-120°, such as about 90°. In one embodiment, the pairing section contact surface comprises two distally arranged concave contact surfaces for mating with a substantially cylindrical handle or rod. The distally arranged contact surfaces can have the same general dimensions (radius, angle) as mentioned for a single contact surface. This embodiment of distal contact surfaces is suitable when a force sensor such as a strain gauge is arranged in the device to measure bending strain in a load bearing element of the device, then it is advantageous that the handle/rod of the weightlifting piece rests on the two distally arranged concave contact surfaces, and as the device and piece are lifted, the weight of the piece rests on the contact surfaces whereas the counteracting force (the lifting force) of the hand holding the assembly acts centrally and oppositely on the device, thus creating a bending strain in the device, which can be measured with a suitably arranged strain gauge. This embodiment offers a simple and economical way of measuring the weight being lifted (force applied). Preferably, in this embodiment there are at least two strain gauges, arranged respectively on each side of the mentioned load bearing element which can be a metal plate or the like rigid element spanning across the device. This arrangement offers a more accurate measurement as there is one strain gauge on the “convex” side of the element as it bends, another strain gauge on the “concave” side, measuring expansion and contraction, respectively. In the preferred embodiment, additional strain gauges to measure and eliminate the temperature-dependency are included. The load bearing element is in some embodiments essentially the grip device itself i.e., its main body piece, then material of the main body is suitably selected so that it has sufficient stiffness.

In another embodiment the pairing section contact surface comprises a centrally arranged elongated concave contact surface. It is however preferred, because of the way the device is gripped and held by the hand, that the contact surface comprises two distal surfaces. This way, in particular with the above-mentioned embodiments with at least two strain gauges for measuring bending strain, it is easier to ensure that the entire force applied by a piece held on the contact surfaces is correctly detected by the sensor(s), and that the counteracting lifting force (of the hand) will not cancel out part of the applied force. For this purpose, in some embodiments, the device comprises a central force transfer element inside the device, which ensures that the lifting force applied by a gripping hand is transmitted centrally to the load bearing element in the device and not distributed along the entire load bearing element. In this

embodiment, the size and shape of the central force transfer element is small enough to accommodate even the smallest of hands such that the measured force is independent of the size of the hand gripping the device, i.e., rendering the force measurements independent to the hand physique of the user.

- 5 In another embodiment of such grip handle with concave pairing section the force sensor is a capacitive force sensor. The capacitive force sensor can be arranged e.g., with two parallel metal plates and a resilient element thereon between which is compressed as the users lifts the device and associated weightlifting piece, altering the capacitance between the plates.

10 It is advantageous that in these embodiments the device can be made thin, meaning that it adds little thickness to the handle of a weightlifting piece being lifted. In one embodiment the pairing section and finger grip section have a total thickness of no more than 15 mm and preferably no more than 12 mm such as 10 mm, 8 mm, or less. This thickness is the thickness between fingers and the piece being lifted, thus in case the finger grip comprises recessions and ridges to better fit fingers (ridges that extend up between fingers) the thickness is
15 measured from the bottom the recesses, from where the fingers would lie. This means that if the device is paired with a e.g. a dumbbell with a handle of 30 mm diameter, the thickness of the assembly held by the user's hand measured across the widest part is no more than 45 mm, and preferably less than 42 mm such as e.g. 40 mm, 38 mm or less. In these embodiments, the benefit of the present invention is that the thickness added by the hand
20 device to the total diameter of the paired hand device and the exercise equipment is minimal, since the pairing section does not fully encircle the exercise equipment, and instead engages only with a portion of the radial part of a handlebar. This minimal increment in thickness allows the user to comfortably grasp the hand device when paired with said exercise equipment.

The at least one contact surface can be, e.g., of leather, faux leather, rubber, silicone, or
25 suitably soft plastic such as but not limited to polyurethane (PUR), polystyrene (PS), polyvinylchloride (PVC), or polyethylene (PE).

Accordingly, the invention can in one aspect be defined as a lifting exercise monitoring hand device comprising a finger grip section and a parallel pairing section for pairing with a weightlifting piece or other exercise equipment, wherein the device comprises at least one
30 force sensor and a wireless data transmitter, the finger grip section having a width accommodating a human user's hand, wherein the at least one force sensor is arranged to measure a weight or force of said weightlifting piece or other exercise equipment paired with the pairing section, the device being configured to assess movement of the device and the transmitter configured to transmit data recorded by the device, and wherein the pairing section
35 has a concave curvature, which can be defined by a radius in the range of 10 to 35 mm and

an angle in the range from 15 to 180°, preferably in the range 45-120°, and more preferably in the range from about 60° to about 100°.

As mentioned, the device incorporates at least one force sensor, configured for weighing a weightlifting piece being lifted (sensing the force applied by its weight) and/or the force applied by the lifting of a piece or other resistance by an exercise piece, such as for example a resistance band. The force sensor is in one embodiment at least one strain gauge, or at least one capacitive force sensor, at least one magnetic force sensor, at least one optical force sensor, a load button or at least one force sensing resistor (FSR).

In an embodiment, the force sensor comprises a strain gauge which is part of a load cell (full bridge or half bridge) and in some embodiments the device comprises a 4-strain gauge load cell. As discussed above, the at least one force sensor comprises in embodiment at least one strain gauge which is preferably arranged longitudinal to the main axis of the device (the axis indicated with 1c in Figure 1b), for measuring bending strain, vertically to the main axis of the device. This way the strain gauge takes up minimal space and can readily be incorporated into the pairing section. In another embodiment, at least two strain gauges are positioned distally, under the respective distal contact surfaces (or under an elongated contact surface). These strain gauges are arranged substantially vertically/ radially from the contact surface and measure direct compression strain, not the bending strain. For more accuracy, two strain gauges can be positioned at each distal end, such as at an angle from each other but both extending radially from the contact surface (example of this is shown in the embodiment of Fig. 1d). In some embodiments piezoelectric force sensors are used instead of strain gauges and they can be suitably arranged as described, one or two at each distal end.

In other embodiments, at least one force sensor can be positioned centrally in the pairing section, for measuring directly the vertical force (compression force) from the piece lifted. This however will require sufficient space in the section to accommodate the force sensor. This can be accomplished e.g. by using space within a central ridge in the finger grip section.

To weigh a weightlifting piece, the user simply grabs the device with the paired weightlifting piece, holding the device in her hand, preferably in a vertical position, so that the weightlifting piece either mates with the device or is connected to the device (via the pairing section) as she lifts the assembly of the device and weightlifting piece. The user then preferably should keep her hand still for a brief moment to get an accurate weight reading. Advantageously, the device is in one embodiment equipped with a signalling unit to provide a signal to the user that the weighing is completed, this can be for example but is not limited to a speaker giving a sound signal, a vibrator giving a vibration signal, a light emitting signal, or a combination of two or more of these. In another embodiment, the user may signal the device to begin weighing

the weightlifting piece e.g., pushing a button or by squeezing the device a fixed number of times or twisting the device.

It is an advantage of the invention that the readings from the at least one force sensor can not only to measure applied force but can as well be used to assess the movement of the device and piece being lifted. As the force created by the piece lifted is a product of its mass and acceleration, i.e., the gravitational force and additional acceleration caused by movement, and the mass can be determined by the device, the acceleration can readily be determined and from it, the movement derived. In other words, the force sensor can be utilized to evaluate exercises of approximately linear motion, regardless of the exercise equipment (e.g., dumbbells, barbells, stands and bars, resistance bands) being paired with the device. For dumbbells, barbells and kettlebells, the list of possible exercises to be evaluated comprises, but is not limited to various types of presses such as military, overhead and shoulder presses, bench press, diamond press, floor kettlebell or dumbbell press, various types of weighted rows with linear motion. It can further be used to assess weighted squats, , sumo squats and various types of deadlifts including exercises such as regular deadlifts, sumo-deadlift, and Romanian-deadlift. It can even be used to assess certain linear core exercises such as side bends and bottom loaded windmill. For bars and stands, where the hand device would be paired with the bar and/or stand, a list of some possible exercises to be assessed comprises but is not limited to dead-hang chin ups and dead-hang pull-ups, various types of dips, various types of push-ups on a push-up stand such as regular, wide and narrow stance push ups, as well as diamond push ups. For resistance bands exercises such as, but not limited to horizontal presses and pulls (e.g., push-ups, lat pulldown, chest press and overhead press) can be assessed. Figs. 5 and 6 illustrate how a force signal is indicative of the movement of the device and paired with a resistance band in a repetitive exercise.

Thus, in one aspect the invention can be defined as a lifting exercise monitoring hand device comprising a finger grip section and a pairing section for pairing with a weightlifting piece or other exercise equipment, preferably parallel to the finger grip section, the device comprising at least one force sensor and a wireless data transmitter, said finger grip section having a width accommodating a human user's hand, wherein the at least one force sensor is arranged to measure a weight or force of said weightlifting piece or other exercise equipment paired with the pairing section, the device being configured to assess movement of the device and the transmitter configured to transmit data recorded by the device, wherein said assessment is at least in part based on output from said force sensor.

In embodiments where the device is used with a resistance band, it may be advantageous to know the elastic modulus of the band and input that to the device, e.g., via an associated app.

Then, the movement distance of the device during exercise with the resistance band can be readily assessed with the force sensor, as the measured force divided with the elastic modulus provides the distance by which the band is stretched according to Hooke's law. In one embodiment the device can be used to measure the elastic modulus, by giving the user instructions (e.g. via an associated app) to stretch the respective resistance band by a given distance, e.g. 10 or 20 cm, in this case the user herself must be able to ascertain the correct distance stretched for this calibration stretch.

In useful embodiments of the invention, the device comprises at least one inertial measurement unit (IMU). The term IMU is as such well known to the skilled person. The IMU of the device measures angular motion and acceleration and preferably determines angular movements including all of pitch, roll and yaw movements of the device. Via the accelerometer data from the IMU, linear motions of the device can as well be assessed. In some embodiments linear motion determinations are complemented with data from the at least one force sensor of the device and in some embodiments linear movements are determined only or dominantly with the at least one force sensor. The IMU of the device detects movements and acceleration of the device with higher dimensionality than a force sensor. Thus, with an IMU the device can generate more descriptive movement output data, which can be used to indicate more accurately movements of the device during exercise and thus assess amount of exercise (e.g., number of reps, degree of movement, etc.) The at least one IMU can then complement the movement determinations of the force sensor and provide additional and more detailed information such as angular movement. This provides more detailed and accurate data and tracking of an exercise. In other words, the IMU and preferably the combination of IMU and the force sensor may be utilized to evaluate or assess exercises of angular motion regardless of the exercise equipment (e.g., dumbbells, barbells, stands and bars, resistance bands) being paired with the device. The list of some exercises that may be assessed with the device comprising an IMU comprises in addition to the above-mentioned, but is not limited to, cleans, cleans and jerks, and snatches, various types of bicep curls such as, but not limited to, regular curls, hammer curl, preacher curls, wrist curls, diagonal rows, various types of more complex presses such as Arnold presses and Cuban presses, various types of chest flies and delt flies such as dumbbell flies and bent over flies, triceps-extensions exercises such as overhead extension and skull-crushers, as well as, triceps-kickbacks. Furthermore, the hand device may be used to assess front, overhead and lateral raises, as well as, rotation resistance exercises, weighted good mornings, weighted sit-ups and windmills and even lunges such as weighted forward, backward and curtsy lunges. It can also be used to assess signature kettlebell exercises such as halos and swings (American, Russian and bicep swings).

In the preferred embodiment, both the IMU and force sensors (e.g., strain gauge) are used collectively to evaluate and analyse the trajectory of the motion and/or measure the force exerted by the user.

The IMU may also be used to obtain greater accuracy in the assessment of exercises of approximately linear motion. Moreover, the IMU may also be utilized to evaluate whether the user is performing an exercise correctly and signal the user if incorrect form is used, e.g., by sound or vibration. For example, in the case of an exercise of approximately linear motion identified by the device and/or associated software (as described in detail below), the IMU may be used to detect how the motion of the hand device deviates from a linear motion, if the deviation from linear motion is sufficiently large, the hand device may issue a signal to the user.

In the case of exercises that require the use of a barbell, stands, bars or the use of two dumbbells and/or kettlebells, where two dumbbells and/or kettlebells, of same weight, are placed in each hand, it is advantageous for the user to hold the hand device in one hand and a dummy device in the other. The dummy device is a copy of the hand device and comprises the same geometry, material selection and weight as the hand device e.g., a suitable finger grip section and a pairing section for pairing with the exercise equipment as specified above. However, the dummy device typically does not include any type of electronics, sensors or transmitters and therefore does not measure any activity by the user. The combination of the hand device and the dummy device, placed in opposite hands, is simply for the user's convenience during a training session wherein both hands are needed for some or all of the exercises. The assessment of the exercising is generally sufficient with a single device, as most exercises involve symmetric use of both hands. When an exercise is performed with only one hand, this can in an embodiment be indicated in an app collecting the device data so that this is accurately logged. Consequently, in some embodiments, the invention provides a set comprising a device as described and a corresponding dummy device with essentially the same dimensions and feel.

In other embodiments the user may use two devices, one in each hand.

The hand device may advantageously comprise an on/off switch, so that the user can turn the device on when he/she starts an exercise, and off when the exercise is completed. The device further typically comprises a battery, preferably a rechargeable battery and a charging port for recharging the battery such as, but not limited to a universal serial bus (USB). Alternatively, the device may be paired with charging pads for wireless charging. The hand device may further comprise a standby mode for optimization of battery usage, wherein the device enters said standby mode if it does not detect movement for a certain period of time and remains in

said standby mode until the device is either switched on/off or detects movement by the user. The time interval of the device before entering said standby mode may be adjusted by the user for example in an associated app.

The device according to one embodiment comprises at least one sensor for sensing force load applied to the device axially, in the direction of the main axis of finger grip section. Such sensor can be a strain gauge or other type of force sensor as mentioned above, for providing a reading of the applied force when a weightlifting piece is held vertically (the handle of the piece held vertically) such as for example when doing hammer curls which requires holding a dumbbell vertically. Preferably the device comprises such axial sensor at each end such that the device can be held one way or the other during such exercise.

The device can further comprise two distally arranged support elements extending substantially vertically from the main axis of the device, in the direction away (or perpendicular) from the pairing section. Such support elements give room for electronic equipment of the device, which allows a thin design of the main part of the device (the elongated finger grip section and the pairing section, when it is adjacent the finger grip). Furthermore, the support elements provide further safety and control for the user when gripping said hand device, wherein the support element prevents sliding (or slipping) of hand during a strenuous exercise.

In some embodiments the pairing section is configured to connect to a piece to be lifted, such that the user does not grip a handle of the piece but only the finger grip, in such embodiments the finger grip is configured to fit by itself the user's hand without a mating weightlifting piece being held in the hand with the finger grip. In such configuration the pairing section can comprise one or more hooks or clamps to mate with and hold the handle of a weightlifting piece. In some embodiments of this kind the pairing section may comprise a bracket connected to the finger grip section via bearings or hinges so that the bracket can rotate on the axis of the finger grip section. Such bracket is configured with suitable fastening means, such as hooks, clamps or the like, to connect a weight, thus the device with the bracket and connected weight can be seen as corresponding to a kettlebell-like structure. The bracket may serve a similar purpose to the support elements of other embodiments, wherein the bracket may serve to keep place in the correct position on the finger grip section and prevent slipping of hand during a strenuous exercise.

In some embodiments, the force sensor may be arranged in said bracket. The force sensor may be at least one strain gauge, or at least one capacitive force sensor, at least one magnetic force sensor, at least one optical force sensor, a load button or at least one force sensing resistor (FSR).

In some embodiments, the bracket and/or the support elements may be used to house electronic equipment of the device.

In one embodiment of the present invention, the device may comprise an assembly of two
5 embodiments, or structural derivatives thereof, of the present invention. For example, a
combination of the embodiments illustrated in Fig. 1(a-d) and Fig. 2(a-d) or Fig. 8(a-b) or a
structural derivative thereof, i.e., a derivative that comprises the same structure as the
embodiment but may be missing the assembly of electronic components such as the force
10 sensor. In such an embodiment, the device may comprise two interacting units to be mated a
first finger grip unit and a handle unit. The first finger grip unit comprising said pairing section
of the first embodiment configured to be mated with the finger grip section of the second
embodiment (i.e., the handle), or a structural derivative thereof, and a handle unit comprising
said pairing section of the second embodiment or structural derivative thereof.

In one embodiment the distally arranged support elements comprise a sensor and circuit for
15 measuring bioelectrical impedance analysis (BIA). Such sensors are as such well known in
the art. When using the device for BIA measurement the user would hold the device and place
both support elements against the skin of e.g., the upper arm or thigh, and the BIA sensor
measures the impedance between the elements through the body. The results of the
measurement may then be processed and displayed to the user through an associated
20 software.

Another aspect of the invention provides a system comprising the hand device of the invention
as described above and associated software, e.g., in the form of an app, where the software
is loadable onto a computer device that comprises a suitable wireless transceiver, such as a
smart phone or smart watch. When the software is loaded and activated on said computer
25 device, the computer device can receive and display data from the hand device. Thus, the
software is configured to transmit sensor data from the hand device to the computer device,
including weight reading data from the weighing sensor (strain gauge) and movement data
from the at least one strain gauge and optional IMU. As the device records force, movement
and position/orientation, the system can provide rep counts, movements and provide an
30 indication of the overall work performed and caloric expenditure.

A benefit of the various embodiments of the present invention is that they are easy to use and
highly transferable, "a grab and go" kind of device. Additionally, for user convenience, the
associated software (or app) may be augmented with a machine learning module such as, but
not limited to, neural networks or any variant thereof, wherein the machine learning module is
35 trained on reference data collected from at least one IMU and/or force sensor for a plethora of

reference exercises. This will allow the associated software to be able to identify exercises being carried out by the user when using the hand device, wherein the trajectory of the exercise is inputted into the machine learning module which is then able to predict/identify what exercise is being carried out. The benefit of the device and/or associated software being able to identify the exercises being carried out is at least threefold, first is that the associated software is able to gather and display a more detailed description of the user's workout, as well as compare the trajectory of the exercise being carried out by the user to that of an "ideal" trajectory for the respective exercise and lastly identification of an exercise by the associated software will allow the associated software to recognize when the user is executing an exercise in an incorrect form. Furthermore, the associated software (or app) may provide exercise plans and pre-determined training session for the user to carry out using the hand device. In another embodiment, the software may play pre-recorded videos of an exercise to be carried out by the user holding the hand device. In yet another embodiment, if the hand device detects incorrect form during a particular exercise, the software may play a video to the user showing the correct form for carrying out the exercise. In one embodiment the system further comprises a sensor belt configured to be strapped on to the torso of the user, comprising a heart rate sensor and an IMU. The sensor belt typically comprises a conventional flexible elastic belt e.g., an elastic textile belt, as such well known in the art to be strapped around the torso of the user, with a heart rate sensor. The heart rate sensor is typically a conventional electrode sensor, as is well known and used in medical and sport heart rate devices. Advantageously, the sensor belt further comprises an IMU, that can record movement and thus can monitor movement of the users during exercise, in particular acceleration and angular movement. Thus, with such sensor belt, the device can assess and record even more exercises, also including exercises involving large movements of the body, e.g., Burpees, Mountain-climbers, Kipping pull-ups and the like.

DETAILED DESCRIPTION

Fig. 1a shows a perspective view of an embodiment of the device 1 with a finger grip section 2 and pairing section 3 with concave curvature. The pairing section in this embodiment comprises two distally arranged concave contact surfaces 4. The hand device has two distally arranged support elements 5 opposite the contact surfaces on which the device can stand and which house the bulk of the electronic equipment of the device. The finger grip section 2 is designed with four finger grooves 6 separated by ridges 7 to better fit the user's hand. The depth of the grooves and size of the ridges are designed to improve gripping of the device 1.

Fig. 1b shows a horizontal cross-section of the same device. A horizontal arranged strain gauge 8 is shown which is arranged on the load bearing element (steel plate) 14 of the device.

Also indicated is a force transfer element 9 which is in between the load bearing element 14 and the finger grip 2.

Fig. 1c shows the cross-section through the 1C plane from Fig. 1b. The horizontally arranged strain gauge 8 is seen on the device-pairing side of the central load bearing element 14 and another strain gauge 15 is located on the opposite side of the element 14. The contact surfaces 4 extend below the general concave surface of the pairing section 3. An IMU 10 is positioned in one of the support elements 5 and an amplifier 11 for the strain gauge. In the same or opposite support element is arranged a transceiver 12, e.g., Bluetooth transceiver.

Fig. 1d shows an end view of the device, in this embodiment two strain gauges 13 arranged vertically (radially) from the contact surface 4 of the pairing section are shown, a second pair (not shown) is arranged in the opposite end. These strain gauges measure direct compression force and can be used instead of or in addition to a central strain gauge measuring bending force.

Fig. 2 shows another embodiment of the invention where the pairing section extends from the finger grip section in the shape of a bracket 21. Fig. 2a shows a front view, 2b is a side view, 2c shows a horizontal cross-section of the finger grip and handle 20, 2d is a cross-section through the plane J. The finger grip section in this embodiment is configured as a generally cylindrical handle 20. In some embodiments, the generally cylindrical handle may comprise patterns and/or ridges and groves to improve gripping. The bracket 21 is fastened with fasteners 23 to rotating holders 22 rotatably joined to the finger grip handle 20 with axial fasteners 24 and bearings 28 so that the bracket 21 can rotate on the axis of the handle 20. The bracket 21 can be arranged with different types of fasteners depending on the type of equipment to be paired with it such as, but not limited to, clamps and hooks. In the embodiment shown, a hook arrangement 25 is clamped on the bracket, which can hold a resistance band 27. (Effectively, the device then corresponds geometrically to a conventional handle of a resistance band equipped with such.) Strain gauges 26 are arranged in the respective arms of the bracket, that measure applied tension. Referring to Fig. 8, different fastener for the hook or clamp 25a may be used, preferably a pairing section with a fastening arrangement for the weightlifting piece to be used and/or the exercise to be carried out. The hook or clamp arrangement 25/25a may comprise a securing piece 29 such as, but not limited to, a Velcro band. In other embodiments, the securing piece 29, may be a lock configurable into open and closed configurations. The securing piece 29 may go over and secure the weightlifting piece in said hook arrangement. In some embodiments, the pairing section may comprise a mechanism (not shown) to readily remove and replace the type of hook or clamp arrangement 25/25a for another type of hook or clamp arrangement.

Fig. 3 shows another embodiment where the unit 1 as described in the first embodiment with a finger grip 2 is paired with a pairing section that structurally corresponds to embodiment in Fig. 2. The pairing section comprises a handle 30 with bracket 31 essentially of the shape as described in the second embodiment and the device 1 and pairing section are configured to work together as a mating assembly, where the electronics and sensors are located in the device 1. Thus, the primary device 1 works essentially as described above and houses sensors as described above, and the handle/bracket section mates with contact surfaces 4. Exercise equipment can be connected to the bracket, here a hook 25 as in the previous embodiment, is clamped on the bracket.

Fig. 4 shows a perspective view of the assembly from Fig. 3. The finger grip unit and associated handle and pairing unit are designed to be held together in the hand of the user (not shown).

Fig. 5 shows output from a strain gauge 8 of the device 1 of the first embodiment as the device was used in exercise with a resistance band. The measured force is shown over time, thus the data shows also the duration of each rep. Fig. 6 shows the calculated movement for each rep ("range of motion"), thus from the data other parameters can be derived, such velocity and acceleration. The raw output of measured force is divided with the elastic modulus of the resistance band to obtain the movement distance in each rep.

Fig. 7 illustrates a user using the hand device for monitoring and measuring a dumbbell bicep curl. The data from the device are wirelessly transmitted to an associated software in a control unit and output data can be displayed on a screen such as a phone. In this exercise the device can measure the angular movement and actual linear movement, for each rep and average values number of reps, duration of each rep and total work performed. Additionally, the device can show deviation from optimal degree of movement, speed, etc.

Fig. 9 shows three photographs of the embodiment illustrated in Fig. 8, wherein the device has been paired with a dumbbell (Fig. 9a), resistance band (Fig. 9b) and kettlebell (Fig. 9c). It is evident, that the weightlifting pieces may readily be mounted on the device and the user may pick up the device paired with the weightlifting equipment and start exercising. In this embodiment, the securing piece is a Velcro band strapped around the weightlifting piece locking it in place on the hook arrangement.

SELECTED SPECIFIC EMBODIMENTS OF THE INVENTION

1. A lifting exercise monitoring hand device comprising a finger grip section and a pairing section for pairing with a weightlifting piece or other exercise equipment, the device comprising at least one force sensor and a wireless data transmitter, said finger grip

section having a length and thickness accommodating a human user's hand, wherein the at least one force sensor is arranged to measure a weight or force of said weightlifting piece or other exercise equipment paired with the pairing section, the device being configured to assess movement of the device and the transmitter configured to transmit data recorded by the device.

2. The lifting exercise monitoring hand device according to embodiment 1, wherein said assessment of movement is at least in part based on output from said force sensor.
3. The lifting exercise monitoring hand device according to embodiment 1 or 2, wherein said at least one force sensor comprises a force sensor selected from a strain gauge, including a strain gauge that is part of a load cell, preferably a 4-strain gauge load cell; a capacitive force sensor, and a piezoelectric force sensor.
4. The lifting exercise monitoring hand device according to embodiment 3, wherein said force sensor comprises at least one strain gauge which is arranged to measure bending strain in a load bearing element or body of the device.
5. The lifting exercise monitoring hand device according to any of embodiments 1 to 3, comprising at least a pair of force sensors arranged distally in said pairing section, one on each end, that extend from the surface of the pairing section.
6. The lifting exercise monitoring hand device according to any of the preceding embodiments, further comprising at least one inertial measurement unit (IMU).
7. The lifting exercise monitoring hand device according to embodiment 6, wherein said device is configured to record angular movement of the device.
8. The lifting exercise monitoring hand device according to any of embodiments 1 to 7, wherein said device is configured to record linear movement of the device.
9. The lifting exercise monitoring hand device according to any of the preceding embodiments, further comprising a sensor for sensing force load applied to the device axially, in the direction of the main axis of finger grip section.
10. The lifting exercise monitoring hand device according to any of the preceding embodiments, comprising a signalling unit, for providing a signal to the user that a weighing operation is completed.
11. The lifting exercise monitoring hand device according to any of the preceding embodiments, wherein said pairing section has a concave curvature with a radius in

the range of 10 to 35 mm and an angle in the range from 15 to 180°, preferably in the range 45-120°, and more preferably in the range from about 60° to about 100°.

- 5 12. The lifting exercise monitoring hand device according to any of the preceding embodiments, wherein the pairing section comprises two distally arranged concave contact surfaces for mating with a substantially cylindrical handle or rod.
13. The lifting exercise monitoring hand device according to any of embodiments 1 to 11, wherein the pairing section comprises a centrally arranged elongated concave contact surface for mating with a substantially cylindrical handle or rod.
- 10 14. The lifting exercise monitoring hand device according to any of the preceding embodiments, wherein the pairing section and finger grip have a total thickness of no more than 15 mm in regions under finger and preferably no more than 10 mm.
- 15 15. The lifting exercise monitoring hand device according to any of the preceding embodiments, comprising two distally arranged support elements extending substantially vertically from the main axis of the finger grip section, and wherein the pairing section comprises a contact surface oppositely arranged to a finger contact area of the finger grip section.
16. The lifting exercise monitoring hand device according to embodiment 15, wherein said distally arranged support elements comprise a sensor and circuit for measuring bioelectrical impedance analysis (BIA).
- 20 17. The lifting exercise monitoring hand device according to any of embodiments 1 to 10 wherein the pairing section comprises one or more hooks or clamps to mate with and hold said handle of a weightlifting piece or said other exercise equipment.
- 25 18. The lifting exercise monitoring hand device according to any of embodiments 1 to 10 wherein the pairing section comprises a bracket connected to the finger grip section via bearings or hinges so that the bracket can rotate on the axis of the finger grip section.
19. The lifting exercise monitoring hand device according to embodiment 18, wherein said bracket comprises force sensors arranged in respective bracket arms that extend from the connection points with the finger grip section.
- 30 20. The lifting exercise monitoring hand device according to embodiment 1, wherein the device comprises two interacting units, a first finger grip unit comprising said finger grip section, and a handle unit, comprising said pairing section, wherein the finger grip unit is configured to mate with the handle unit.

21. A lifting exercise monitoring hand device comprising a finger grip section and a parallel pairing section for pairing with a weightlifting piece or other exercise equipment, the device comprising at least one force sensor and a wireless data transmitter, said finger grip section having a length and thickness accommodating a human user's hand, wherein the at least one force sensor is arranged to measure a weight or force of said weightlifting piece or other exercise equipment paired with the pairing section, the device being configured to assess movement of the device and the transmitter configured to transmit data recorded by the device, wherein the pairing section has a concave curvature shaped to mate with a handle of said weightlifting piece or other exercise equipment.
22. The lifting exercise monitoring hand device according to embodiment 21 wherein the pairing section has a concave curvature, which can be defined by a radius in the range of 10 to 35 mm and an angle in the range from 15 to 180°, preferably in the range 45-120°, and more preferably in the range from about 60° to about 100°
23. The lifting exercise monitoring hand device according to any embodiment 21 or 22, wherein the pairing section comprises two distally arranged concave contact surfaces for mating with a substantially cylindrical handle or rod.
24. The lifting exercise monitoring hand device according to any of embodiments 21 to 22, wherein the pairing section comprises a centrally arranged elongated concave contact surface for mating with a substantially cylindrical handle or rod.
25. The exercise monitoring hand device according to any of embodiments 21 to 24, wherein the pairing section and finger grip have a total thickness of no more than 15 mm in regions under fingers and preferably no more than 10 mm.
26. The lifting exercise monitoring hand device according to any of embodiments 21 to 25, comprising two distally arranged support elements extending substantially vertically from the main axis of the finger grip section.
27. A lifting exercise monitoring hand device comprising a finger grip section and a pairing section for pairing with a weightlifting piece or other exercise equipment, the device comprising at least one force sensor and a wireless data transmitter, said finger grip section having a length and thickness accommodating a human user's hand, wherein the at least one force sensor is arranged to measure a weight or force of said weightlifting piece or other exercise equipment paired with the pairing section, the device being configured to assess movement of the device and the transmitter

configured to transmit data recorded by the device, wherein the pairing section further comprises a fastener to be paired with an exercise equipment.

28. The lifting exercise monitoring hand device according to embodiment 27, wherein the fastener is a hook to be paired with a resistance band and the like equipment.

29. The lifting exercise monitoring hand device according to embodiment 27, wherein the fastener is a clamp to be paired with a dumbbell or the like equipment.

30. The lifting exercise monitoring hand device according to any of embodiments 27 to 29, wherein the finger grip section is of cylindrical shape.

31. The lifting exercise monitoring hand device according to any of embodiments 27 to 30, wherein the finger grip section further comprises a grippy pattern of ridges and valleys on the outer surface of the cylinder.

32. The lifting exercise monitoring hand device according to any of embodiments 27 to 31, wherein the outermost layer of the finger grip section comprises rubber or silicone or leather.

33. The lifting exercise monitoring hand device according to any of embodiments 27 to 32, wherein the finger grip section is connected to the pairing section through at least one bracket.

34. The lifting exercise monitoring hand device according to the preceding embodiment, wherein the bracket is attached to both ends of the pairing section through axial fasteners and is able to rotate around the finger grip section.

35. The lifting exercise monitoring hand device according to the preceding embodiment, wherein the at least one bracket further comprises at least one arm, wherein the at least one arm is of an irregular quadrilateral shape (i.e., an angled L-shape).

36. The lifting exercise monitoring hand device according to either embodiment 34 or 35, wherein two or more arms connect the finger grip section to the pairing section.

37. The lifting exercise monitoring hand device according to any of embodiments 33 to 36, wherein the at least one force sensor is arranged in the at least one bracket, preferably in the at least one arm of the bracket.
- 5 38. The lifting exercise monitoring hand device according to any of embodiments 33 to 37, wherein an IMU is arranged in the finger grip section or pairing section or in the at least one bracket or in the at least one arm of the bracket.
39. The lifting exercise monitoring hand device according to any of the preceding embodiments, wherein said lifting exercise monitoring hand device further comprises
10 a sensor and circuit for measuring bioelectrical impedance analysis (BIA).
40. A system comprising a lifting exercise monitoring hand device according to any of embodiments 1 to 39, and associated software loadable onto a computer device with a wireless receiver such as a smart phone or smart watch, wherein when said software is loaded and activated on said computer device, said computer device is able to
15 receive and display data from the lifting exercise monitoring device.
41. The system according to embodiment 40, wherein said associated software is capable of identifying exercises from data transmitted from the lifting exercise monitoring device using predictions made by a trained machine learning module.
- 20 42. The system according to any of embodiments 1 to 42, comprising a sensor belt configured to be strapped on to the torso of the user, comprising a heart rate sensor and an IMU.

CLAIMS

1. A lifting exercise monitoring hand device comprising a finger grip section and a pairing section for pairing with a weightlifting piece or other exercise equipment, the device comprising at least one force sensor and a wireless data transmitter, said finger grip section having a length and thickness accommodating a human user's hand, wherein the at least one force sensor is arranged to measure a weight or force of said weightlifting piece or other exercise equipment paired with the pairing section, the device being configured to assess movement of the device and the transmitter configured to transmit data recorded by the device.
2. The exercise monitoring hand device according to claim 1, wherein said assessment of movement is at least in part based on output from said force sensor.
3. The lifting exercise monitoring hand device according to claim 1 or 2, wherein said at least one force sensor comprises a force sensor selected from a strain gauge, including a strain gauge that is part of a load cell, preferably a 4-strain gauge load cell; a capacitive force sensor; and a piezoelectric force sensor.
4. The lifting exercise monitoring hand device according to claim 3, wherein said force sensor comprises at least one strain gauge which is arranged to measure bending strain in a load bearing element or body of the device.
5. The lifting exercise monitoring hand device according to claim 1 or 2, comprising at least a pair of force sensors arranged distally in said pairing section, one on each end, that extend from the surface of the pairing section.
6. The lifting exercise monitoring hand device according to any of the preceding claims, further comprising at least one inertial measurement unit (IMU), wherein said device is configured to record angular movement of the device.
7. The lifting exercise monitoring hand device according to any of the preceding claims, further comprising a sensor for sensing force load applied to the device axially, in the direction of the main axis of finger grip section.

8. The lifting exercise monitoring hand device according to any of the preceding claims, comprising a signalling unit, for providing a signal to the user that a weighing operation is completed.
- 5 9. The lifting exercise monitoring hand device according to any of the preceding claims, wherein contact surfaces of said pairing section have a concave curvature with a radius in the range of 10 to 35 mm and an angle in the range from 15 to 180°, preferably in the range 45-120°, and more preferably in the range from about 60° to about 100°.
- 10 10. The lifting exercise monitoring hand device according to any of the preceding claims, wherein the pairing section comprises two distally arranged concave contact surfaces for mating with a substantially cylindrical handle or rod.
- 15 11. The lifting exercise monitoring hand device according to any of claims 1 to 9, wherein the pairing section comprises a centrally arranged elongated concave contact surface for mating with a substantially cylindrical handle or rod.
- 20 12. The exercise monitoring hand device according to any of claims 9 to 11, wherein the pairing section and finger grip have a total thickness of no more than 15 mm in regions under finger and preferably no more than 10 mm.
- 25 13. The lifting exercise monitoring hand device according to any of claims 1 to 8 wherein the pairing section comprises one or more hooks or clamps to mate with and hold said handle of a weightlifting piece or said other exercise equipment.
- 30 14. The lifting exercise monitoring hand device according to any of claims 1 to 8 wherein the pairing section comprises a bracket connected to the finger grip section via bearings or hinges so that the bracket can rotate on the axis of the finger grip section.
- 35 15. The lifting exercise monitoring hand device according to claim 14, wherein said bracket comprises force sensors arranged in respective bracket arms that extend from the connection points with the finger grip section.
16. The lifting exercise monitoring hand device according to claim 1, wherein the device comprises two interacting units, a first finger grip unit comprising said finger grip section, and a handle unit, comprising said pairing section, wherein the finger grip unit is configured to mate with the handle unit.

17. A lifting exercise monitoring hand device comprising a finger grip section and a parallel pairing section for pairing with a weightlifting piece or other exercise equipment, the device comprising at least one force sensor and a wireless data transmitter, said finger grip section having a length and thickness accommodating a human user's hand, wherein the at least one force sensor is arranged to measure a weight or force of said weightlifting piece or other exercise equipment paired with the pairing section, the device being configured to assess movement of the device and the transmitter configured to transmit data recorded by the device, wherein the pairing section has a concave curvature shaped to mate with a handle of said weightlifting piece or other exercise equipment.

18. The lifting exercise monitoring hand device according to claim 17 wherein the pairing section has a concave curvature, which can be defined by a radius in the range of 10 to 35 mm and an angle in the range from 15 to 180°, preferably in the range 45-120°, and more preferably in the range from about 60° to about 100°

19. The lifting exercise monitoring hand device according to any of claims 1 to 18, comprising two distally arranged support elements extending substantially vertically from the main axis of the finger grip section, and wherein the pairing section comprises a contact surface oppositely arranged to a finger contact area of the finger grip section.

20. The lifting exercise monitoring hand device according to claim 19, wherein said distally arranged support elements comprise a sensor and circuit for measuring bioelectrical impedance analysis (BIA).

21. A system comprising a lifting exercise monitoring hand device according to any of claims 1 to 20, and associated software loadable onto a computer device with a wireless receiver such as a smart phone or smart watch, wherein when said software is loaded and activated on said computer device, said computer device is able to receive and display data from the lifting exercise monitoring device.

22. The system according to claim 21, comprising a sensor belt configured to be strapped on to the torso of the user, comprising a heart rate sensor and an IMU.

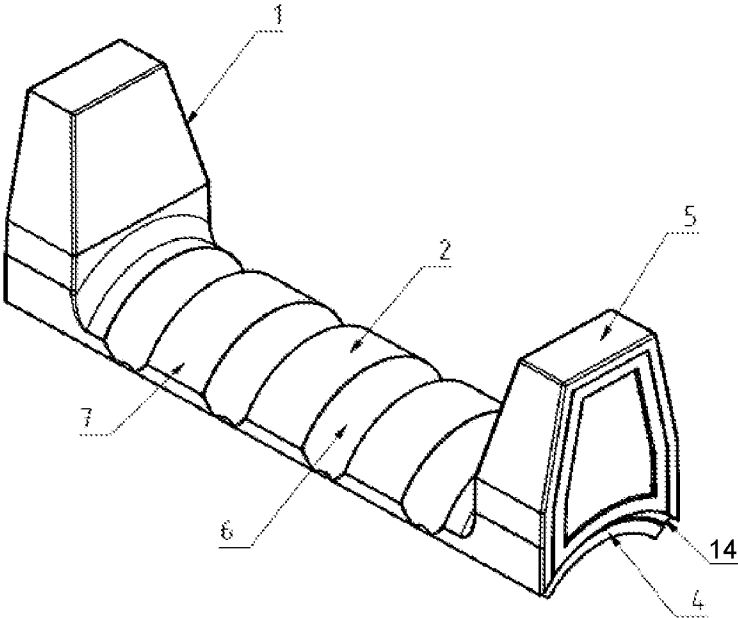


FIG. 1a

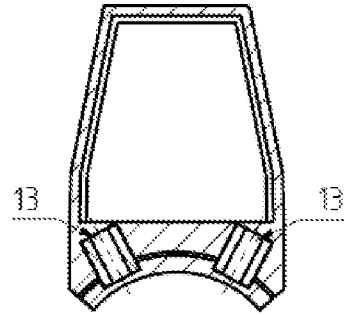


FIG. 1d

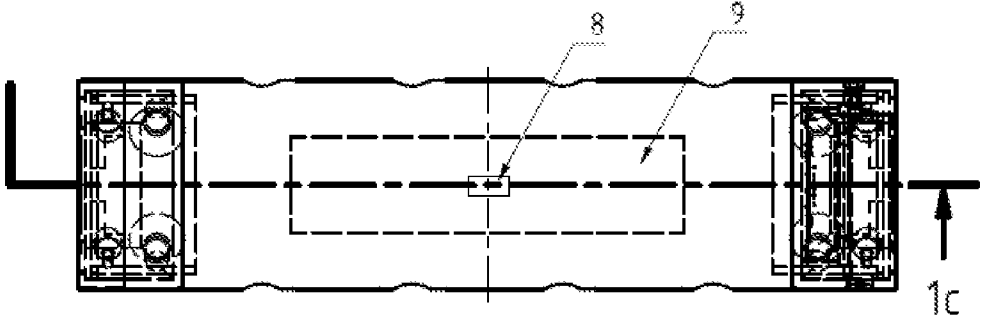


FIG. 1b

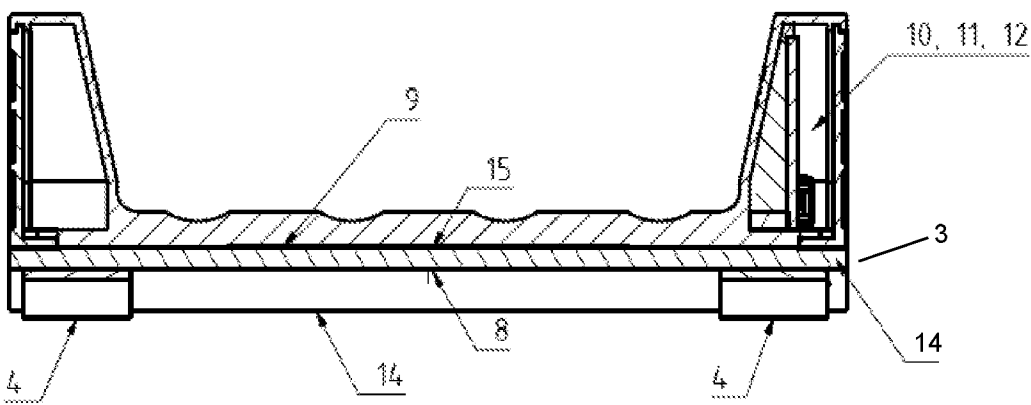


FIG. 1c

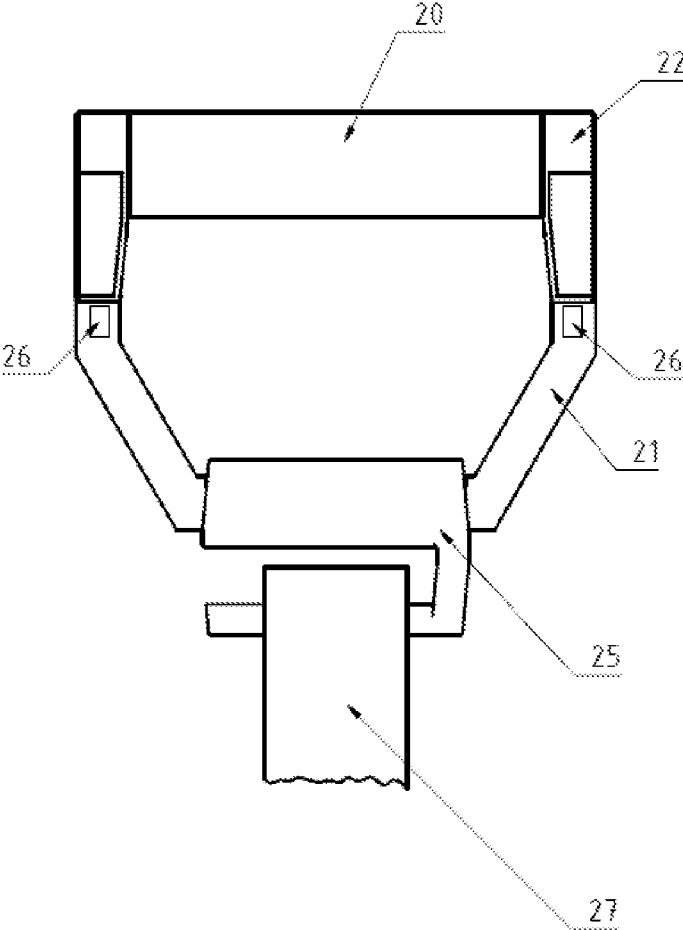


FIG. 2a

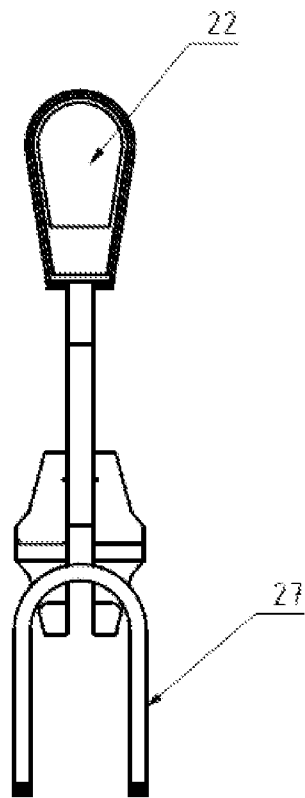


FIG. 2b

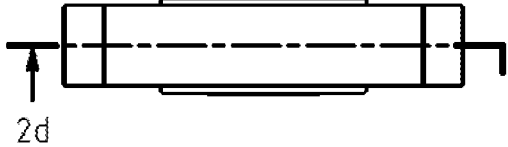


FIG. 2c

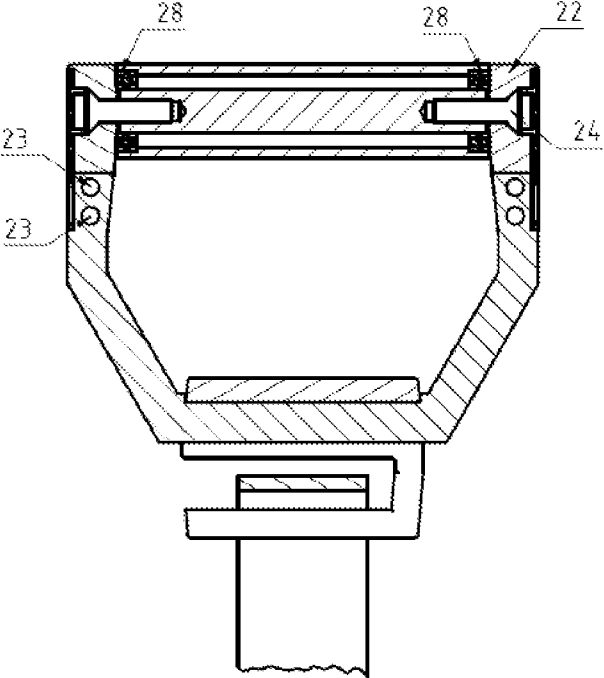


FIG. 2d

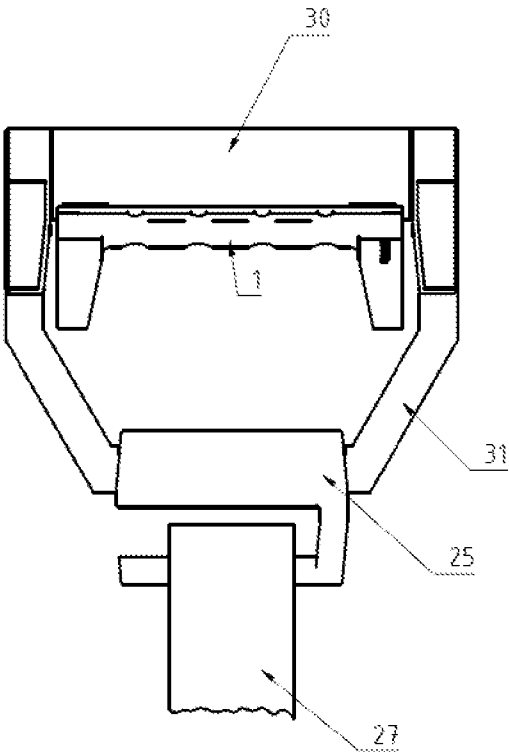


FIG. 3a

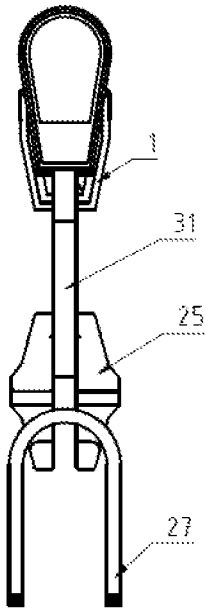


FIG. 3b

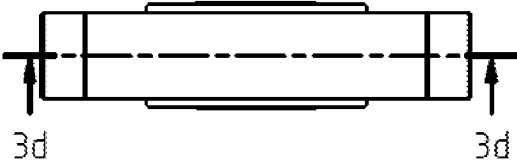


FIG. 3c

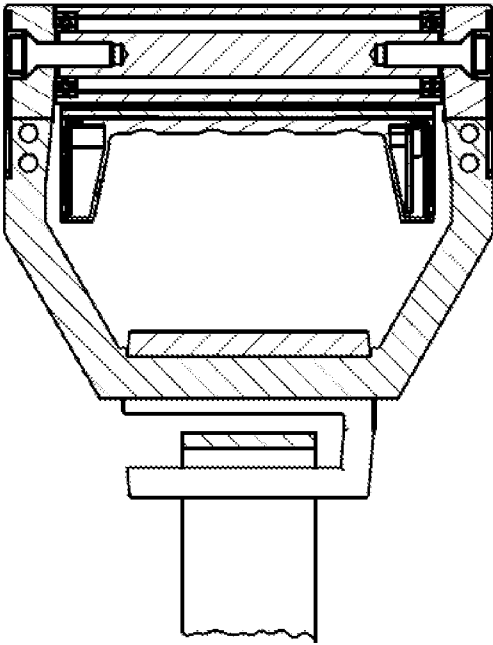


FIG. 3d

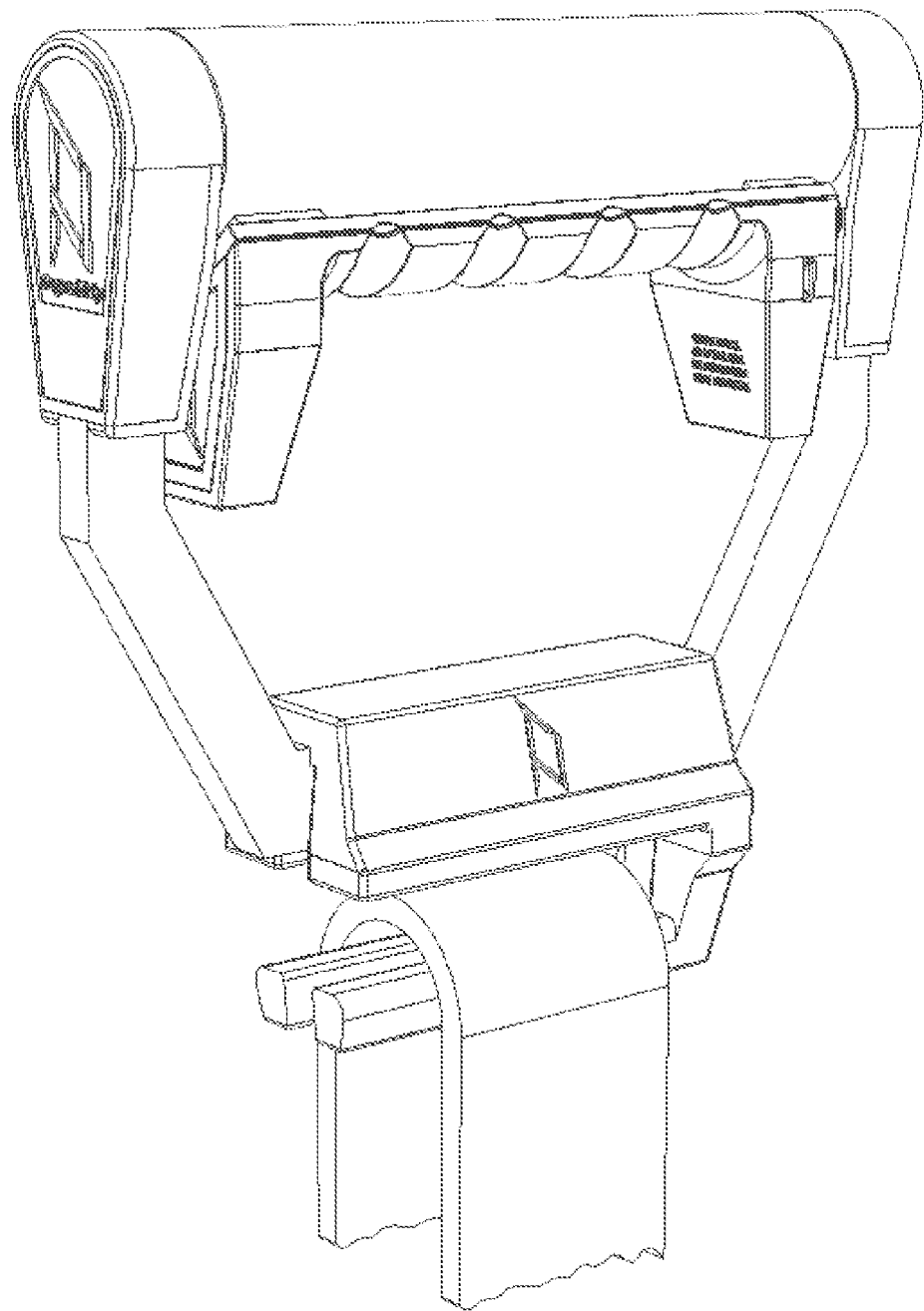


FIG. 4

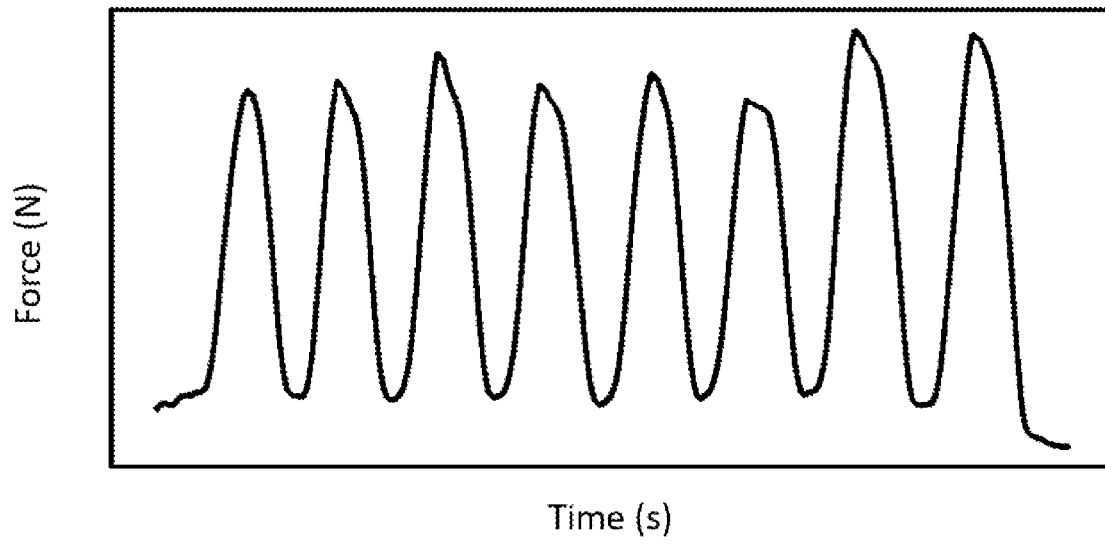


FIG. 5

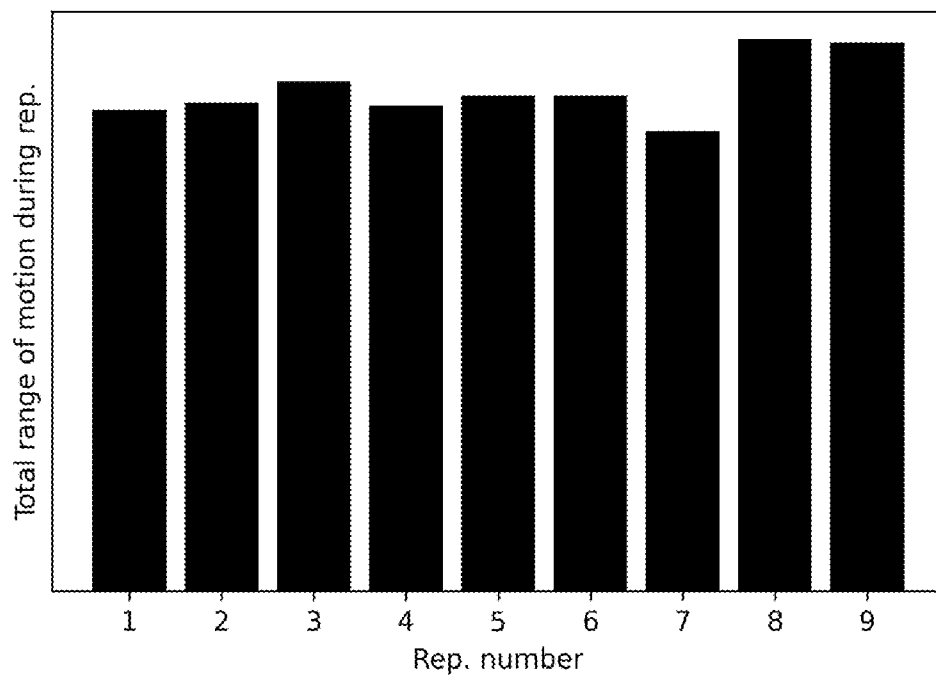


FIG. 6

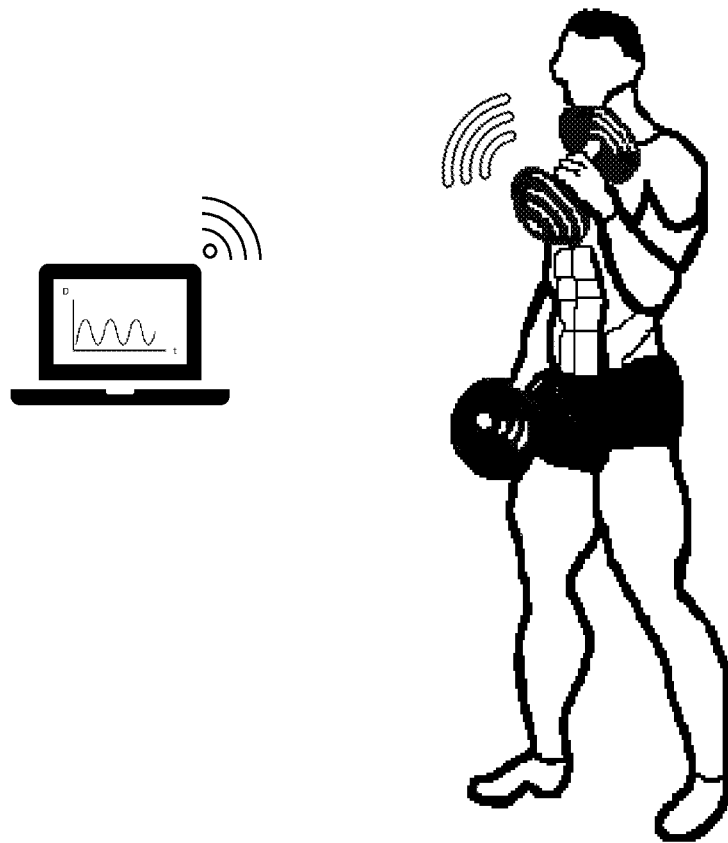


FIG. 7

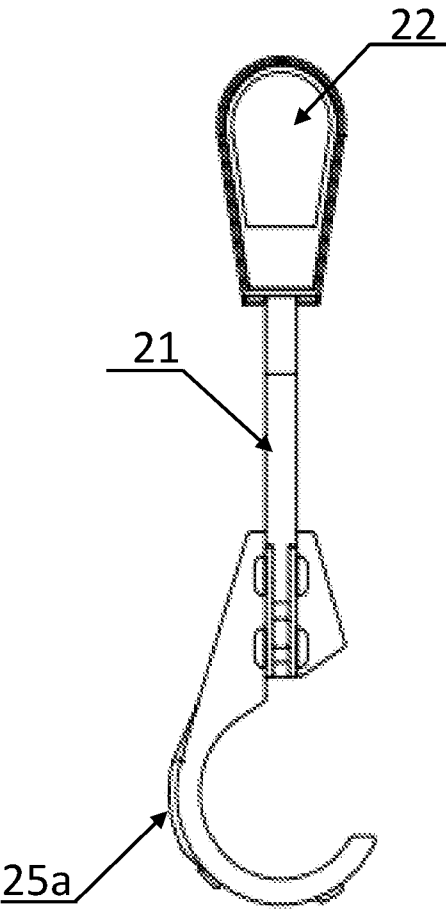


FIG. 8a

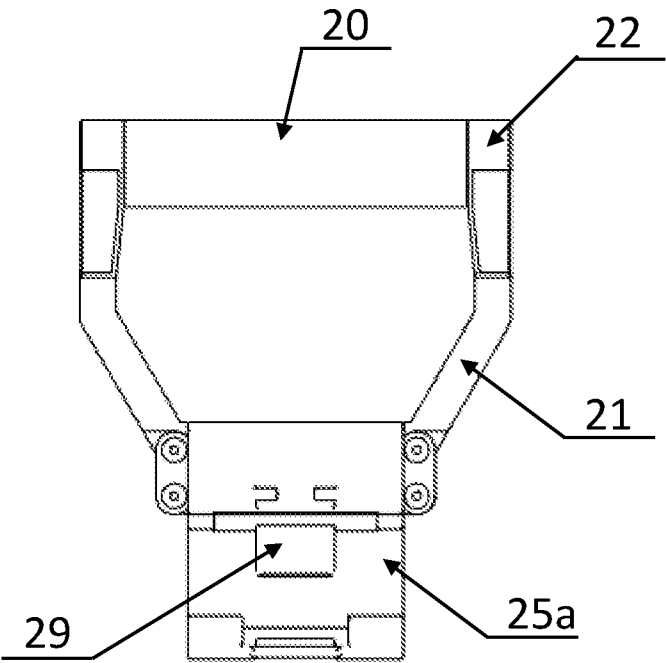


FIG. 8b

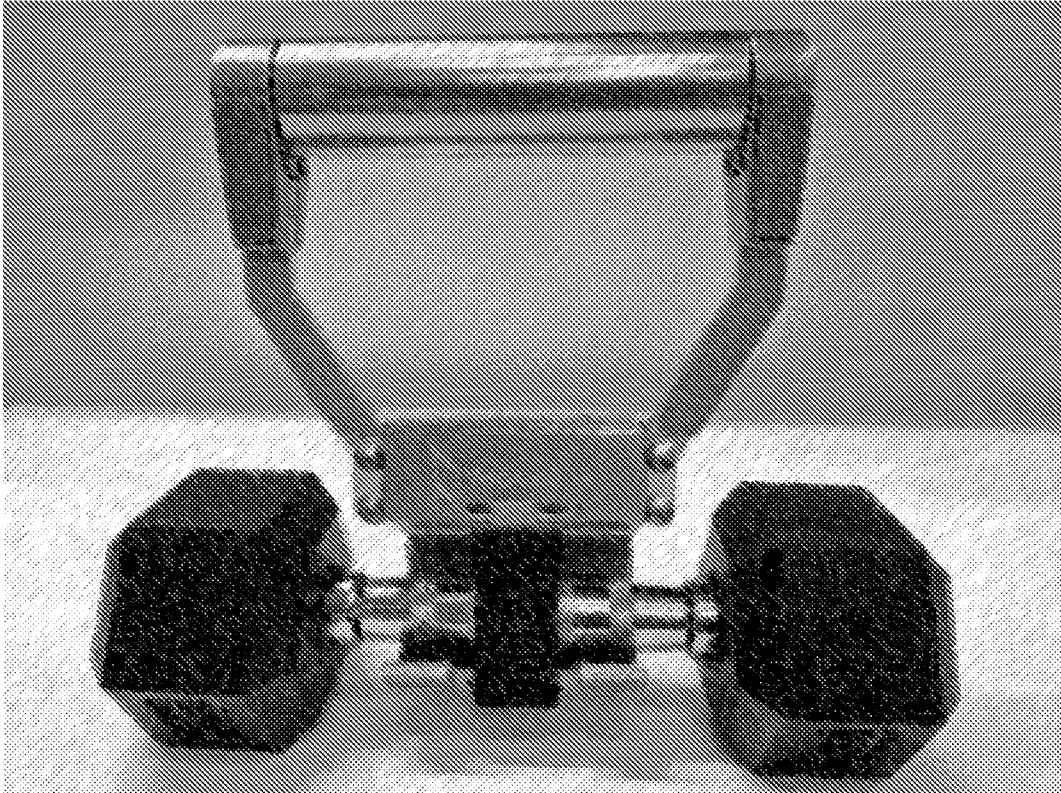


FIG. 9a

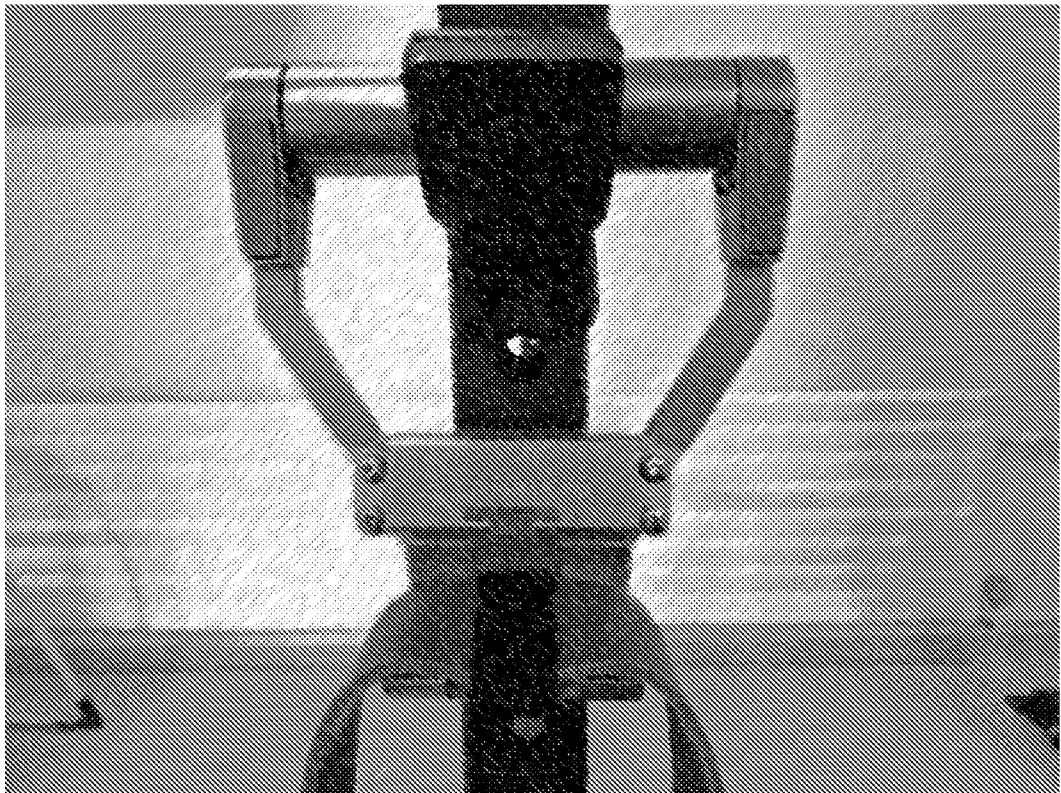


FIG. 9b

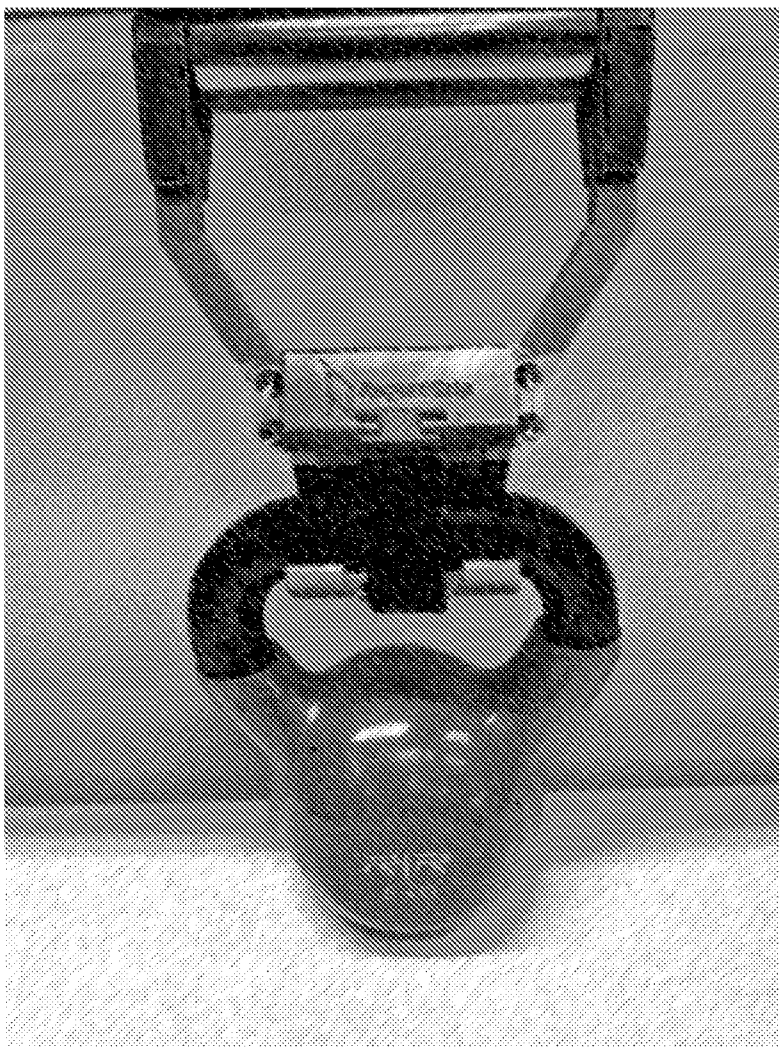


FIG. 9c

INTERNATIONAL SEARCH REPORT

International application No
PCT/IS2024/050003

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	A63B24/00	A63B21/00
	A63B21/072	A63B71/00
		A63B71/06
ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
A63B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2021/308524 A1 (CERNASOV ANDREI [US] ET AL) 7 October 2021 (2021-10-07) cited in the application	1-12,17, 18,20-22
A	pages 2-7; claims; figures -----	13-16,19
X	US 2019/290962 A1 (OSBRINK THOMAS W [US]) 26 September 2019 (2019-09-26) cited in the application	1-4,6, 9-15, 17-19,21
A	pages 2-9; claims; figures -----	5,7,8, 16,20,22
X	US 2023/106092 A1 (JAQUISH JOHN PAUL [US] ET AL) 6 April 2023 (2023-04-06)	1-4,6,7, 9,10, 12-14, 17-21
A	pages 5-21; claims; figures -----	5,8,11, 15,16,22
	- / - -	
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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"E" earlier application or patent but published on or after the international filing date		"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means		"&" document member of the same patent family
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Date of the actual completion of the international search		Date of mailing of the international search report
15 October 2024		23/10/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Herry, Manuel

INTERNATIONAL SEARCH REPORT

International application No

PCT/IS2024/050003

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2021/178217 A1 (IX CHRISTOPHER [US] ET AL) 17 June 2021 (2021-06-17)	1-4, 6, 8-13, 16-19, 21
A	pages 3-10; claims; figures -----	5, 7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IS2024/050003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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