(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 442 334 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.10.2024 Bulletin 2024/41

(21) Application number: **22843845.3**

(22) Date of filing: **01.12.2022**

(51) International Patent Classification (IPC):
A63B 69/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
A63B 23/16; A63B 21/00069; A63B 21/023; A63B 21/0428; A63B 69/0048; A63B 71/0622; A63B 21/0087; A63B 21/055; A63B 24/0062; A63B 2071/0072; A63B 2071/0625; A63B 2220/12; A63B 2220/13; A63B 2220/16; A63B 2220/20;

(Cont.)

(86) International application number:
PCT/ES2022/070776

(87) International publication number:
WO 2023/099808 (08.06.2023 Gazette 2023/23)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **01.12.2021 ES 202132384 U**

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(54) **FINGER EXERCISE DEVICE AND SYSTEM FOR TRAINING, WARM-UP AND/OR REHABILITATION OF MUSCLES, TENDONS AND PHALANGE PULLEYS AND METHOD OF DETERMINING ADHESION FOR CLIMBERS**

(57) The invention relates to a finger exercising device and system, comprising a base (10), including at least one longitudinal guide (11), a carpal support (20), at least one distal phalangeal support (30) guided by the at least one longitudinal guide (11); at least one elastic element (40) configured to offer elastic resistance to the sliding of the at least one distal phalangeal support (30); wherein the carpal support (20) defines a concave carpal seating (21) between a sagittal carpal surface, mostly facing a sagittal direction (DS), and a longitudinal carpal surface, mostly facing a longitudinal direction (DL) perpendicular to the sagittal direction, which are adjacent to one another, forcing an arched, semi-arched, or extended grip of a hand between the concave carpal seating (21) and the concave distal phalangeal seating (31).

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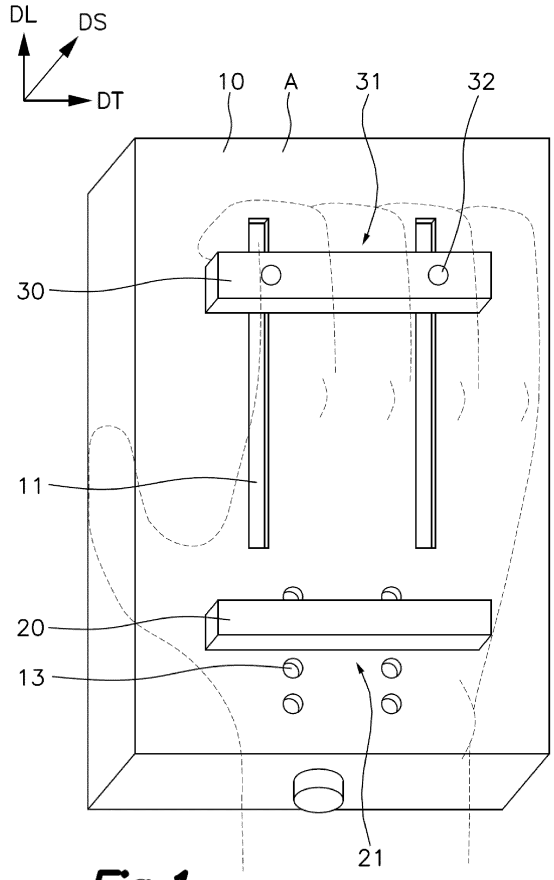

Fig. 1

(52) Cooperative Patent Classification (CPC): (Cont.)
A63B 2220/51; A63B 2220/52; A63B 2220/72;
A63B 2220/74; A63B 2220/75; A63B 2220/803;
A63B 2225/20; A63B 2225/50

Description

Technical Field

[0001] The present invention relates to a finger exercising device and system for the training, warming up, and/or rehabilitation of muscles, tendons, and pulleys of the phalanges of the fingers.

[0002] The present exercising device is particularly applicable in physical therapy for the recovery and rehabilitation of hand injuries, particularly for athletes such as climbers, and also for the training and strengthening of muscles, tendons, and pulleys of the phalanges of the fingers.

[0003] The system proposed can also be used for the embodiment of a method for the determination of adhesion for climbing.

State of the Art

[0004] Certain sports, such as climbing, for example, require a specific training of the fingers for the training, warming up, and/or rehabilitation of muscles, tendons, and pulleys of the phalanges.

[0005] Namely, in the case of climbing, given that all the body weight hangs from the fingers, the fingers, and particularly the tendons and pulleys, are subjected to a great deal of stresses. These stresses will differ according to whether the grip position of the hand is arched, semi-arched, or extended, with specific exercises being required for each of said grip positions.

[0006] The arched grip consists of flexion of the metacarpophalangeal joints (between the metacarpals and the proximal phalanges), proximal interphalangeal joints (between the proximal phalanges and the intermediate phalanges), and distal interphalangeal joints (between the intermediate phalanges and the distal phalanges) in hypertension, this grip being the system that puts the greatest stress on the flexor system, mainly on the pulleys joining the flexor tendon sheaths to the phalanges, where injuries in climbers are common.

[0007] The semi-arched grip consists of extension of the metacarpophalangeal joints, flexion in hypertension of the proximal interphalangeal joints, forming an approximate angle of 90°, and hyperextension of the distal interphalangeal joints.

[0008] The extended grip consists of hyperextension of the metacarpophalangeal joints and flexion of the proximal and distal interphalangeal joints in hypertension.

[0009] For the training, warming up, and/or rehabilitation of muscles, tendons, and pulleys of the phalanges of the fingers fixed exercising devices are known, such as hangboards, which are fixed to a wall or hung from the ceiling or from a tree, and allow the user to hang from same. However, these devices are very bulky and heavy and do not allow adjustment of the stress withstood by the muscles, tendons, and pulleys of the phalanges of the fingers of the user, as this will depend on the user's weight.

[0010] Hand grip exercisers in the form of pincers provided with a spring which offers adjustable resistance to the closing of the grip exerciser are also known. Hand grip exercisers of this type are intended for being held between the thumb, and part of the palm, and the medial phalanges of the hand, allowing the warming up and exercising of the muscles and tendons associated with closing the hand, mainly located in the forearm. The geometry of exercising devices of this type does not allow a secure and easy gripping thereof between the area of the hand where the carpal bones are located and the ends of the fingers where the distal phalanges are located, thereby preventing finger exercise by means of a semi-arching or arching of the fingers.

[0011] Other devices for exercising the muscles and tendons, mainly located in the forearm, associated with closing the hand, are also known, for example by means of documents CN103638647, US689652, and WO2018000412.

[0012] These exercising devices, and many other similar devices existing on the market, consist of two parallel, guided handles with an elastic element that keeps them separated. Like in the hand grip exercisers described above, these devices are intended for the handles to be held between the thumb, and part of the palm, and the medial phalanges of the hand. These devices can therefore be considered equivalent to the hand grip exercisers described above and have the same limitations, as it does not allow a secure and easy gripping thereof between the area of the hand where the carpal bones are located and the ends of the fingers where the distal phalanges are located either.

[0013] The finger exercising device described in document WO2017171534 is also known. This device has a base provided with a support for the thumb and a distal phalangeal support, provided with a concave housing, associated with the base in a sliding manner and connected to a spring. This device allows the gripping between the thumb and the distal phalanx of a finger inserted into the concave housing of the distal phalangeal support, exercising the muscles and tendons of said finger. The geometry of this exercising device determines a position of the hand that does not allow finger exercise by means of a semi-arching or arching of the fingers.

[0014] The present invention solves the above problems as well as others by providing an exercising device which, as a result of its geometry and arrangement, allows isometric and eccentric working of the three main finger grips: extended, semi-arched, and arched, allowing the correct sliding of tendons in all these grips.

[0015] The rest of the known exercising devices do not enable said exercises together.

Brief Description of the Invention

[0016] The present invention relates to a finger exercising device for the training, warming up, and/or reha-

bilitation of muscles, tendons, and pulleys of a phalanx, in particular the third phalanges and the pulleys through the arching of the fingers.

[0017] The object being presented therefore has the following three different applications or main objectives:

1) Warming up and preventing injuries:

In the sport of climbing, having to warm up before starting is common, with particular emphasis on the area of the fingers and, very particularly, the third phalanges, which require more attention as it is an area with many tendons where the blood supply is lower (and even more so at low temperatures) than in areas with muscle. This need to properly warm up the hands is absolutely essential in rock climbing (outdoor climbing, mountain climbing), where there is usually a low temperature (it should be noted here that climbing, from a medium-high level,
requires low temperatures that facilitate the adhesion of the skin to the rock) and the climber hardly has any tools to warm them up and exercise them before exposing them to great strains.

2) Strength/resistance training:

Since the crimp and its dimensions are chosen by the climber, and since the force exerted by the accessory is adjustable, the invention lends itself to performing with same strength training, as is done on climbing walls, but without the need to resort to same. Its dimensions make it suitable to enable being used anywhere and at any time, which may be of interest even for being used in the workplace by climbers who work in offices, sitting down, or in similar
conditions, in addition to being used in the home while reading, watching TV, or performing various tasks.

3) Rehabilitation:

Finger injuries, particularly tendon and pulley injuries, are very common in climbing. These injuries are often due to a bad warm-up, as a cold finger (lacking a proper warm-up) suffers much more than once it is warmed up. These injuries take a long time to heal as it is an area that is not particularly irrigated and require long periods of time (2 to 6 months, for example) accompanied by exercises (usually taken to the threshold of pain) to help bring blood to the affected area for better healing (thus avoiding possible fibromyalgia, for example). The accessory presented has the appropriate qualities to carry out these exercises, even measuring the improvement by being able to adjust the intensity, thus observing over time the increase in strength in the affected area. In addition, it is more than remarkable that few physical therapists are aware of the exercises to be performed to heal these injuries, as they are very rare injuries (outside the group of climbers) in areas that do not require special strength (again, outside the group of climbers). Thus, only physical therapists specializing in this area or sport effectively treat these injuries. This makes the product one more accessory to which medical professionals can resort when recommending finger rehabilitation.

[0018] To achieve the previously mentioned objectives, the proposed exercising device comprises:

a base, which defines the longitudinal direction, transverse direction, and sagittal direction orthogonal to one another and a front face perpendicular to the sagittal direction, and wherein the base includes at least one longitudinal guide extending in the longitudinal direction;

a carpal support, associated with the base, to support the base of the palm of the hand where the carpal bones are located;

at least one distal phalangeal support, associated with the base, to support the ends of the fingers where the distal phalanges are located;

the distal phalangeal support being guided by the at least one longitudinal guide, for example two parallel longitudinal guides, allowing a relative sliding between the carpal support and the distal phalangeal support in the longitudinal direction along a travel distance between maximum and minimum extension positions;

at least one elastic element configured to offer elastic resistance to the relative sliding, in the longitudinal direction, between the carpal support and the mentioned at least one distal phalangeal support.

[0019] The carpal support is understood to be a support element intended for supporting therein the part of the palm of the hand where the carpal bones are located, i.e., the base of the palm of the hand in the area thereof closest to the wrist.

[0020] Likewise, the distal phalangeal support is also understood to be a support element, typically a crimp, intended for supporting therein the part of the ends of the fingers where the distal phalanges are located.

[0021] The base will be a casing the front face of which will be the front face of the base that can be seen from the sagittal direction, typically being a face mostly perpendicular to said sagittal direction. Therefore, the front face will extend mainly in the longitudinal direction and transverse direction.

[0022] Preferably, the carpal and distal phalangeal

supports extend in the transverse direction and are substantially parallel to one another and are facing in the longitudinal direction.

[0023] The present invention proposes, in a manner that is unknown in the state of the art, the following:

the carpal support defines a concave carpal seating between a sagittal carpal surface, mostly facing the sagittal direction, and a longitudinal carpal surface, mostly facing the longitudinal direction and adjacent to the sagittal carpal surface, forcing an arched, semi-arched, or
extended grip of a hand between the concave carpal seating (21) and the concave distal phalangeal seating (31).

[0024] Optionally, the mentioned at least one distal phalangeal support may be a replaceable distal phalangeal support, selected from a set of different distal phalangeal supports, or from a set of different distal phalangeal supports with different sizes, grip configurations, surface textures and/or made of different materials, , which replaceable distal phalangeal support (30) is fixed to the device by means of a releasable fixing element or by means of a releasable fixing element formed by complementary protrusions and recesses, magnets, and/or Velcro fasteners.

[0025] The replacement of the distal phalangeal support allows the device to be adapted to different exercises, to simulate different climbing surfaces, to adapt the device to different user hand sizes, etc.

[0026] It is also proposed that said at least one distal phalangeal support can define at least one concave distal phalangeal seating, between a longitudinal distal phalangeal surface mostly facing the longitudinal direction and a sagittal distal phalangeal surface, mostly facing the sagittal direction, or a sagittal distal phalangeal surface defined by the front face of the base, which are adjacent to one another. The concave distal phalangeal seating may have a bulbed shape or an irregular roughness.

[0027] A concave seating will be understood to be one with a cross-section, in a plane perpendicular to the transverse direction, that is concave, providing a firm and secure support point for positioning the base of the palm of the hand or the ends of the fingers.

[0028] The sagittal carpal and distal phalangeal surface, mostly facing the sagittal direction, will also be understood to be a surface that can be accessed by the user in the sagittal direction, the projection of said surface in the sagittal direction being greater than the projection of said surface in the remaining longitudinal and transverse directions.

[0029] Likewise, the longitudinal carpal and distal phalangeal surface, mostly facing the longitudinal direction, will be a surface that can be accessed by the user in the longitudinal direction, the projection of said surfaces in the longitudinal direction being greater than the projection of said surfaces in the remaining sagittal and transverse directions. The longitudinal carpal and distal phalangeal surfaces will be in opposition, oriented in opposite directions and not facing one another.

[0030] Said concave seatings allow the insertion, into the concave interior thereof, of the base of the palm of the hand or of the fingertips, in the sagittal direction, i.e., in a direction perpendicular to the longitudinal direction in which the distal phalangeal support slides.

[0031] This allows a user to support the part of the hand that contains the carpal bones in the concave carpal seating and to support the fingertip where the distal phalanges are located in the concave distal phalangeal seating. The flexion of the different joints of the hand will cause the sliding of the distal phalangeal support, bringing it closer to the carpal support, overcoming the elastic resistance of the elastic element. The position and geometry of the carpal and distal phalangeal supports described above determines that the hand is positioned in an arched, semi-arched, or extended grip during the exercise.

[0032] According to a preferred embodiment, the longitudinal distal phalangeal surface and the sagittal distal phalangeal surface may be surfaces of the distal phalangeal support which define a concavity in the distal phalangeal support. That is, the concave distal phalangeal seating may be defined by at least one concavity defined in a front face of the distal phalangeal support accessible in the sagittal direction. For example, the support may include one or more concavities for the insertion of one or more fingers.

[0033] Alternatively, it is proposed that the longitudinal distal phalangeal surface can be a surface of the distal phalangeal support, and the sagittal distal phalangeal surface can be a surface of the front face of the base, adjacent to the distal phalangeal support. That is, the concave distal phalangeal seating may be a concave region defined between the distal phalangeal support and a sagittal surface of the front face of the base, said concave region being accessible in the sagittal direction and adjacent to the distal phalangeal support. According to this embodiment, the concave distal phalangeal seating is defined between the distal phalangeal support and a part of a front surface of the base on which the distal phalangeal support slides.

[0034] Similarly, the longitudinal carpal surface and the sagittal carpal surface could be surfaces of the carpal support which together define a concavity in the carpal support. That is, the concave carpal seating may be defined by a concavity defined in a front face of the carpal support accessible in the sagittal direction.

[0035] Alternatively, the longitudinal carpal surface could be a surface of the distal phalangeal support, and the sagittal carpal surface could be a surface of the front face of the base. That is, the distal phalangeal seating may be defined between the carpal support and a front surface of the front face of the base, accessible in the sagittal direction and adjacent to the carpal support. According to this second alternative, the concave carpal seating would be defined between the carpal support and

a part of a front surface of the base on which the carpal support is fixed, and providing a support, on the base, for the base of the palm of the hand.

[0036] Alternatively, the mentioned at least one distal phalangeal support can define a sagittal distal phalangeal surface mostly facing the sagittal direction and providing at least one frictional distal phalangeal seating. The sagittal distal phalangeal surface may be, for example, flat, smooth, honeycomb-shaped, or bulbed or have an irregular roughness. This distal phalangeal support may be one from among several interchangeable distal phalangeal supports available for placement in the exercising device, such that this allows a friction grip, while others provide a concave seating which provides a different grip for other types of exercises.

[0037] Preferably, the front surfaces of the front face of the base which are adjacent to the carpal support and to the distal phalangeal support and define the concave carpal and distal phalangeal seatings will be substantially coplanar with one another.

[0038] According to another embodiment, the carpal support and/or the distal phalangeal support can be fixed to the rest of the device in different positions by means of a releasable fixing element, modifying the separation between the carpal support and the distal phalangeal support. The releasable fixing element can be formed, for example, by complementary protrusions and recesses, magnets, and/or Velcro fasteners.

[0039] For example, the base may further include, on the front face, multiple anchoring points for the detachable fixing of the carpal support in different positions of the base by means of a releasable fixing element, thus allowing adjustment of the initial distance between the carpal support and the distal phalangeal support, being adapted to different hand sizes.

[0040] In such case, the releasable fixing element may consist, for example, of pins protruding from the carpal support in the sagittal direction which can be tightly inserted into complementary openings provided on the front face of the base.

[0041] Alternatively or additionally, the exercising device may further include an adjustment device configured to modify the maximum extension and/or minimum extension position of the travel distance between the carpal support and the distal phalangeal support, adapting the travel distance to different user hand sizes. This adjustment device may consist, for example, of an adjusting screw which, by means of the rotation thereof, causes the fixing point for fixing the distal phalangeal support to the longitudinal guide to move.

[0042] The aforementioned at least one elastic element may consist, for example, of at least one spring, of at least one band of elastic material, or of at least one pneumatic piston, located between a first stop associated with the mentioned at least one distal phalangeal support and a second stop associated with the base causing the elastic compression and/or elongation of the at least one elastic element with the relative movement between the at least one distal phalangeal support and the carpal support.

[0043] A sealed pneumatic piston is understood to act a spring by means of compression and decompression of the gas contained therein.

[0044] The exercising device may also include an elastic resistance adjustment device configured to modify the tension of the at least one elastic element, which determines the force needed for the relative movement between the carpal support and the distal phalangeal support. Said modification of the tension of the at least one elastic element may be obtained, for example, by means of adjusting the distance between the first stop and the second stop in the longitudinal direction.

[0045] The second stop may be movable, in the longitudinal direction, by means of the elastic resistance adjustment device. By moving the second stop, the degree of compression of the spring, band of elastic material, or pneumatic piston is modified, and the elastic resistance offered to the movement of the distal phalangeal support is thus adjusted according to the user's needs and preferences.

[0046] The elastic resistance adjustment device may be, for example, a screw which, by means of the rotation thereof, determines the position of the second stop in the longitudinal direction.

[0047] According to the preferred embodiment of the invention, the mentioned at least one longitudinal guide which consist of at least one rod fixed to the base, with the mentioned at least one spring, constituting the at least one elastic element, being placed around said rod.

[0048] Other alternative embodiments of the mentioned at least one longitudinal guide and of the elastic element are also provided. For example, the longitudinal guide could be a groove extending in the longitudinal direction made in the base itself, and the elastic element could be a flexible structure made of plastic, metal, or another material, for example in the form of a leaf spring.

[0049] According to one embodiment of the invention, the exercising device can integrate a control device connected to at least one measuring device selected from a strain sensor configured to determine the force exerted by the user when moving the distal phalangeal support, for example a load cell, a movement sensor configured to determine the movement made by the distal phalangeal support, and/or an exercising device configuration sensor configured to detect at least one of the settings of the exercising device selected by the user.

[0050] Typically, the exercising device configuration sensor is selected from an elastic element tension adjustment sensor, a sensor for detecting the minimum and/or maximum extension positions of the travel distance, a detector for detecting the fixing position of the carpal supports and/or of the distal phalangeal supports, and/or an identification sensor for identifying, from among the various selectable supports, the distal phalangeal support actually fixed to the exercising device at the time of performing an exercise.

[0051] It is proposed that each of the different distal phalangeal supports available for being fixed on the device can include an identification element detectable by means of an identification sensor integrated in the exercising device, for example a RFID antenna, a magnetic element for determining a different position and/or intensity and/or orientation, pins, or openings located in positions that can be measured by an optical sensor, etc.

[0052] In addition to the aforementioned measuring device or measuring devices, the exercising device can further include other additional measuring devices selected from a humidity sensor, a temperature sensor, an atmospheric pressure sensor, a GPS positioning sensor, an orientation sensor, a time meter configured to determine the time and/or date at which an exercise is performed and/or the duration thereof.

[0053] All this information can be relevant when assessing the evolution of the exercise performed by the user, because atmospheric values, the time of day, or the time of year may affect the user's performance, because in climbing, the conditions of the rock and of the user's skin are essential in said performance and are affected by said atmospheric conditions.

[0054] The location also allows the collected data to be compared with data obtained in previous sessions at the same site, or to be stored for future sessions at the same site.

[0055] Preferably, the control device integrates a memory configured to store the information received by said control device, typically the information furnished by the measuring devices.

[0056] The control device may also integrate an interface configured to transmit the information received by the control device and/or the information stored in the memory, for example by means of a display screen or by means of light or sound indicators, and/or to input information to the control device, for example through a keyboard. The information input to the control device may, for example, be selected from user identification information or geographic location information.

[0057] Optionally, the control device may be connected to a communication antenna to transmit the information obtained by the measuring devices to a portable computing device, typically a smart phone, a tablet, or a laptop. The communication antenna may be, for example, an antenna transmitting under the WiFi or BLUETOOTH protocol.

[0058] The antenna may also be used to receive information that is external to the exercising device, for example GPS location information, weather information, user identification information, etc.

[0059] The at least one distal phalangeal support will preferably be elongated in the transverse direction, offering support for the index finger up to the pinky.

[0060] Alternatively, the mentioned at least one distal phalangeal support may be a plurality of independent distal phalangeal supports, one next to the other, each one being guided in the longitudinal direction and defining an independent concave distal phalangeal seating.

[0061] In such case, each independent distal phalangeal support could have an independent elastic element, with the elastic resistance of each independent elastic element being independently adjustable.

[0062] According to a second aspect, the present invention relates to a finger exercising system for the training, warming up, and/or rehabilitation of muscles, tendons, and pulleys of a phalanx.

[0063] The exercising system will comprise an exercising device, like the one described above, provided with a control device connected to at least one measuring device, and a portable computing device.

[0064] The portable computing device, typically a smart phone, a tablet, or a laptop, comprises at least one communication antenna and/or a connection port, a memory, an interface, such as a display screen and a keyboard, and a computing device executing a software application.

[0065] It is proposed that the control device of the exercising device is connected to a communication antenna, or a connection port, and is configured to transmit information from the mentioned at least one measuring device to the portable computing device.

[0066] The software application executed by the portable computing device will be configured to execute an algorithm to analyze the information supplied by the control device of the exercising device.

[0067] Said analysis may merely consist of creating trend graphs in comparison with historical or other users' data, future trend projections, or can be analyzed to suggest new exercise patterns in response to the results of the exercises performed, among many other possible analyses.

[0068] It is also proposed that the portable computing device includes at least one additional measuring device selected from a humidity, temperature, and/or atmospheric pressure sensor, a GPS positioning sensor, an orientation sensor, a time meter configured to determine the time and/or date at which an exercise is performed and/or the duration thereof.

[0069] The portable computing device will be configured to transmit the information provided by said at least one additional measuring device to the exercising device, and/or to analyze said information together with the information transmitted from the exercising device by the algorithm.

[0070] This allows, for example, the number of measuring devices integrated in the exercising device to be reduced, taking advantage of many of the sensors which are already integrated as a standard in all smart phones.

[0071] The portable computing device may include a connection to a remote server and may be configured for the transmission of the information obtained by the sensor devices and/or additional sensor devices, or for the transmission of the result of the analysis performed by the algorithm to said remote server.

[0072] This allows, for example, the storage of the data

in the cloud, allowing it to be consulted from any device, to be compared with other users' data, etc.

[0073] According to a third aspect, the invention proposes a method of determining adhesion for climbing by means of a system such as the one described above.

[0074] Adhesion shall be understood to be the coefficient of frictional adhesion between the user's hand and a surface that said hand is gripping.

[0075] The proposed method comprises transporting the exercising device to a climbing site, configuring the exercising device according to predefined adjustment parameters, and performing a grip test by placing a hand in the exercising device, supporting the carpal area of the palm of the hand in the carpal support and the distal phalangeal area of the hand in the distal phalangeal support, in the extended grip position, and performing a relative sliding between the carpal support and the distal phalangeal support towards the arched grip position along the travel distance until the distal phalangeal support escapes from the user's hand.

[0076] Next, the method proposes calculating, by means of the algorithm executed by the software application, a climbing performance estimate based on the analysis of the result of the grip test, in relation to stored reference data which correlates the results of the grip tests and climbing performance data.

[0077] Climbing performance data is understood to be data indicating the grip of the climber with the rock during climbing. This climbing performance data can be, for example, the time taken to make the upward climb, the frequency or number of slips of the climber, or other parameters such as a personal assessment of the climber.

[0078] Therefore, because of the result of the grip test, the climbing performance estimate will allow the climber to have an idea as to whether the climbing conditions are suitable before starting.

[0079] Preferably, the reference data contains results of the grip tests performed with the same predefined parameters as the grip test to be analyzed.

[0080] Predefined parameters are understood to include the type of distal phalangeal support and fixing position thereof for fixing to the exercising device, as well as the tension of the elastic element.

[0081] Preferably, the predefined adjustment parameters include the placement of a distal phalangeal support defining a frictional distal phalangeal seating in a sagittal distal phalangeal surface mostly facing the sagittal direction, or the use of a surface mostly facing the sagittal direction of the distal phalangeal support as a frictional distal phalangeal seating.

[0082] In either of the two options, the distal phalanges will not be supported on a concave seating, which offers greater grip, but rather on a surface that is substantially flat and perpendicular to the sagittal direction, so the grip it provides will be reduced and obtained mainly by friction.

[0083] It is proposed that the point of the travel distance where the escape occurs is determined by the strain sensor, by the movement sensor, or by an analysis performed by the algorithm on the information supplied by the strain sensor and/or by the movement sensor.

[0084] It is also proposed that the stored reference data also correlates the results of the grip tests and the climbing performance data with stored information referring to existing environmental atmospheric values when and where the grip tests and climbs were performed, which data is stored as reference data.

[0085] The method further proposes obtaining environmental atmospheric values at the climbing site, calculating the climbing performance estimate considering said environmental atmospheric values measured and those stored as reference data.

[0086] According to another embodiment of the invention, the stored reference data can also correlate the results of the grip tests and the climbing performance data with stored information about the geographic location of where the grip tests and climbs were performed, which data is stored as reference data. The method may therefore comprise obtaining values of the geographic location where the grip test is performed, and calculating the climbing performance estimate by comparing the result of the grip test with stored reference data obtained at the same geographic location, or at an equivalent geographic location with similar climbing conditions, for example with a similar geology and/or similar climbing difficulty.

[0087] It will be understood that the software application can be configured to execute the operations needed to perform the mentioned method.

[0088] A method of using the exercising device by means of adjustment and use indications provided by a mobile application which would consider the use history of the exercising device by the user is also contemplated.

[0089] The user would be registered in the application, generating a personal profile, where they would input their relative data, for example, their level of climbing experience, prior or present injuries, etc. Based on the input data, the user could ask the application to generate preferred settings of the exercising device and exercise routines, to be chosen from warm-up, strengthening, or rehabilitation exercises.

[0090] Preferably, the application would also store the exercising device use history and would modify the settings or routines over time based on prior use of the exercising device by that particular user.

[0091] The mobile application could show cartoons, drawings, or videos demonstrating the proposed exercises to be performed.

[0092] Other features of the invention will become apparent in the following detailed description of an embodiment.

Brief Description of the Figures

[0093] The aforementioned and other advantages and features will be better understood from the following detailed description of an embodiment in reference to the attached drawings which are to be interpretated in an

illustrative and non-limiting manner, in which:

Figure 1 shows a perspective view of an embodiment of the exercising device, showing the position of a hand of a user using the device with a discontinuous line;

Figure 2 shows the same perspective view as Figure 1 but showing the carpal and distal phalangeal supports separated from the rest of the device;

Figure 3 shows a cross-section of the exercising device shown in Figure 1 along a plane coinciding with one of the first longitudinal guides;

Figure 4 shows another cross-section of the exercising device shown in Figure 1 along a central plane of the exercising device coinciding with the elastic resistance adjustment device in the form of a screw;

Figure 5 shows the same cross-section shown in Figure 4, but according to another embodiment;

Figure 6 shows a schematic perspective view of the proposed system, in which the exercising device and also the portable computing device are shown.

Detailed Description of an Embodiment

[0094] The attached figures show illustrative, non-limiting embodiments of the present invention.

[0095] The present invention consists of an exercising device including a base (10) which defines the longitudinal direction (DL), transverse direction (DT), and sagittal direction (DS) orthogonal to one another and a front face (A) facing the sagittal direction (DS), and wherein the base (10) includes at least one longitudinal guide (11) extending in the longitudinal direction (DL).

[0096] In this preferred embodiment, said base (10) is box-shaped with general dimensions somewhat greater than those of a mobile phone (15 cm x 10 cm x 1.4 cm).

[0097] The base has associated, protruding from the front face (A) thereof, a carpal support (20) and a distal phalangeal support (30) in the form of a climbing crimp, consisting of a small slat, for example made of plastic, wood, or another material, between 6 mm and 26 mm thick in the sagittal direction (DS), to reproduce the climbing gestures known as "extension", "semi-arching", and "arching" of the fingers.

[0098] The inside of the base (10) contains two parallel rods extending in the longitudinal direction (DL), by way of first longitudinal guides (11).

[0099] A holder (33), contained inside the base (10), is placed on both rods, allowing the sliding thereof in the longitudinal direction (DL) inside the base (10). Each rod has a spring placed around same, said spring acting as an elastic element (40), compressed between the holder (33), performing the first stop functions of the spring, and a second stop (42). The position of the second stop (42) in the longitudinal direction (DL) is adjustable by means of an elastic resistance adjustment device (43) which, in this embodiment, is a screw extending in the longitudinal direction and which, by means of the rotation thereof, causes the second stop (42) to move in the longitudinal direction, increasing or reducing the elastic compression of the spring, and therefore, adjusting the force required to move the holder (33).

[0100] The front face (A) of the base (10) has two elongated slots in the longitudinal direction (DL) through which a releasable fixing element (32) connects the distal phalangeal support (30), located above the front face (A) of the base (10), with the holder (33) contained therein, allowing the movement of the distal phalangeal support (30) in the longitudinal direction, on the front face (A) of the base (10), together with the movement of the holder (33) contained inside the base (10).

[0101] A concave distal phalangeal seating (31), where the user can insert the distal ends of his/her fingers in a direction parallel to the sagittal direction (DS), is defined between the front face (A) of the base (10), which is in the form of a flat surface extending in the longitudinal direction (DL) and transverse direction (DT), and the distal phalangeal support (30), protruding from said front face (A) in the sagittal direction (DS). Said distal phalangeal seatings (31) provide a firm gripping point.

[0102] Similarly, a carpal seating (21), where the user can introduce the base of the palm of his/her hand, where the carpal bones are located, in a direction parallel to the sagittal direction (DS), is also defined between said flat surface of the front face (A) of the base (10) and the carpal support (20), protruding from said front face (A) in the sagittal direction (DS).

[0103] Alternatively, both the carpal seating (21) and the distal phalangeal seating (31) can be defined not between the front face (A) of the base (10) and the corresponding support, but rather by a depression or hole provided in the carpal support (20) itself and/or in the distal phalangeal support (30) itself, on a face facing the sagittal direction (DS).

[0104] Said arrangement of the carpal seating (21) and distal phalangeal seating (31) determines the position of the hand in an arched, semi-arched, or extended grip, which allows exercising the hand both in an eccentric and in a concentric and isometric manner.

[0105] Furthermore, the releasable fixing element (32) allow replacement of the distal phalangeal support (30) with another different distal phalangeal support (30), with a different texture, material, roughness, in order to provide the user with different sizes, textures, or relief patterns.

[0106] This would allow customizing the device to the user's needs, to the treatment of a specific type of injury, to a training for a specific climbing texture, or to adapt the device to the dimensions of the user's fingers or to adapt it for one-finger, two-finger, and three-finger training grips, for example.

[0107] Different distal phalangeal supports can be obtained, for example, by means of additive manufacturing techniques such as 3D printing, or by means of subtractive manufacturing techniques such as grinding with a computer-controlled machine tool, with both techniques allowing the precise manufacture of different distal phalangeal supports (30).

[0108] The flat surface of the front face (A) of the base (10) can include a measurement ruler to be able to observe the quantity of movement performed, and to thus know (by means of a table provided in the instruction manual or by means of a second ruler) the force being exerted at all times based, likewise, on how the elastic resistance adjustment device (43) has been adjusted. This force reading could also be done digitally by adding a small electronic device that measures movement and, by knowing the initial tension of the elastic element (40) when the user does not exert pressure on same, the effort made by the user in each movement of the distal phalangeal support (30) could be calculated.

[0109] According to one embodiment of the invention, the device can integrate a control device 50, for example a programmable logic controller, with a memory 52, connected to a measuring device 51. In this example, the measuring device is a strain sensor measuring the force applied on the elastic element by the user. In this example, the measuring device 51 consists of a load cell, for example of a dielectric material.

[0110] Optionally, this exercising device can also include a communication antenna 53 for the transmission of the data obtained to a remote server or to a portable computing device 60, or for the reception of data, for example other users' data or meteorological data, provided by the remote server or by the remote computing device 60.

[0111] In the embodiment shown in Figure 6, the exercising device described is connected to a remote computing device 60 forming an exercising system. The remote computing device 60 integrates a computing device 61, connected to a memory 62 and to a communication antenna 63.

Claims

1. A finger exercising device for the training, warming up, and/or rehabilitation of muscles, tendons, and pulleys of a phalanx, comprising:

   a base (10), which defines the longitudinal direction (DL), transverse direction (DT), and sagittal direction (DS) orthogonal to one another and a front face (A) perpendicular to the sagittal direction (DS), and wherein the base (10) includes at least one longitudinal guide (11) extending in the longitudinal direction (DL);
   a carpal support (20), associated with the base (10), to support the base of the palm of the hand where the carpal bones are located;
   at least one distal phalangeal support (30), associated with the base (10), to support the ends of the fingers where the distal phalanges are located;
   the distal phalangeal support (30) being guided by the at least one longitudinal guide (11) allowing a relative sliding between the carpal support (20) and the distal phalangeal support (30) in the longitudinal direction (DL) along a travel distance between maximum and minimum extension positions;
   at least one elastic element (40) configured to offer elastic resistance to the sliding, in the longitudinal direction (DL), of the at least one distal phalangeal support (30);
   characterized in that
   the carpal support (20) defines a concave carpal seating (21) between a sagittal carpal surface, mostly facing the sagittal direction (DS), and a longitudinal carpal surface, mostly facing the longitudinal direction (DL), adjacent to the sagittal carpal surface, forcing an arched, semi-arched, or extended grip of a hand between the concave carpal seating (21) and the concave distal phalangeal seating (31).

2. The exercising device according to claim 1, wherein the exercising device integrates a control device (50) connected to at least one measuring device (51) selected from a strain sensor configured to determine the force exerted by the user when moving the distal phalangeal support (30), a movement sensor configured to determine the movement made by the distal phalangeal support (30) and/or an exercising device configuration sensor configured to detect at least one of the settings of the exercising device selected by the user.

3. The exercising device according to claim 2, wherein the exercising device configuration sensor is selected from an elastic element tension adjustment sensor, a sensor for detecting the minimum and/or maximum extension positions of the travel distance, a detector for detecting the fixing position of the carpal supports and/or of the distal phalangeal supports, and/or an identification sensor for identifying, from among the various selectable supports, the distal phalangeal support actually fixed to the exercising device at the time of performing an exercise.

4. The exercising device according to claim 2 or 3, wherein the at least one measuring device (51) further includes another measuring device selected from a humidity sensor, a temperature sensor, an atmospheric pressure sensor, a GPS positioning sensor, an orientation sensor, a time meter configured to determine the time and/or date at which an

exercise is performed and/or the duration thereof.

5. The exercising device according to claim 2, 3, or 4, wherein the control device (50) integrates a memory (52) configured to store the information received by said control device (50).

6. The exercising device according to claim 2, 3, 4, or 5, wherein the control device (50) integrates an interface configured to transmit the information received by the control device and/or the information stored in the memory, and/or to input information to the control device, or to input information to the control device selected from user identification information, or geographic location information and/or includes a communication antenna (53).

7. The exercising device according to any one of the preceding claims, wherein the mentioned at least one distal phalangeal support (30) is a replaceable distal phalangeal support (30), selected from a set of different distal phalangeal supports (30), or from a set of different distal phalangeal supports (30) with different sizes, grip configurations, surface textures and/or made of different materials, which replaceable distal phalangeal support (30) is fixed to the device by means of a releasable fixing element (32) or by means of a releasable fixing element (32) formed by complementary protrusions and recesses, magnets, and/or Velcro fasteners.

8. The device according to any one of the preceding claims, wherein at least one distal phalangeal support (30) defines at least one concave distal phalangeal seating (31), or at least one concave distal phalangeal seating (31) having bulbed shape or an irregular roughness:

defined between a longitudinal distal phalangeal surface mostly facing the longitudinal direction (DL) and a sagittal distal phalangeal surface, mostly facing the sagittal direction (DS), or a sagittal distal phalangeal surface defined by the front face (A) of the base (10), which are adjacent to one another; and/or
mostly facing the sagittal direction (DS) and providing at least one frictional distal phalangeal seating.

9. The exercising device according to claim 8, wherein the sagittal carpal and distal phalangeal surfaces are substantially coplanar with one another.

10. The exercising device according to any one of the preceding claims, wherein

the carpal support (20) and/or the distal phalangeal support (30) can be fixed to the rest of the device in different positions by means of a releasable fixing element (22, 32), or by means of a releasable fixing element (22, 32) formed by complementary protrusions and recesses, magnets, and/or Velcro fasteners, modifying the separation between the carpal support (20) and the distal phalangeal support (30); and/or wherein
an adjustment device is configured to modify the maximum extension and/or minimum extension position of the travel distance between the carpal support (20) and the distal phalangeal support (30), adapting the travel distance to different user hand sizes.

11. The exercising device according to any one of the preceding claims, wherein the at least one elastic element (40) consists of at least one spring, at least one band of elastic material or at least one pneumatic piston, located between a first stop associated with the mentioned at least one distal phalangeal support (30) and a second stop (42) associated with the base (10), causing the elastic compression and/or elongation of the at least one elastic element with the relative movement between the at least one distal phalangeal support (30) and the carpal support (20).

12. The exercising device according to claim 11, wherein an elastic resistance adjustment device (43) is configured to modify the tension of the at least one elastic element (40), which determines the force needed for the relative movement between the carpal support (20) and the distal phalangeal support (30), or to modify the tension of the at least one elastic element by means of adjusting the distance between the first stop and the second stop (42) in the longitudinal direction (DL).

13. The exercising device according to any one of the preceding claims, wherein:

the at least one distal phalangeal support (30) is elongated in the transverse direction (DT), offering support for the index finger up to the pinky, or
the mentioned at least one distal phalangeal support (30) are a plurality of independent distal phalangeal supports, each one being guided in the longitudinal direction (DL) and defining an independent concave distal phalangeal seating (31), or
the mentioned at least one distal phalangeal support (30) are a plurality of independent distal phalangeal supports, each one being guided in the longitudinal direction (DL) and defining an independent concave distal phalangeal seating (31), with each independent distal phalangeal support (30) having an independent elastic ele-

ment (40), with the elastic resistance of each elastic element (40) being independently adjustable.

14. A finger exercising system for the training, warming up, and/or rehabilitation of muscles, tendons, and pulleys of a phalanx, comprising an exercising device such as the one described in one of claims 2 to 6, or in any of their dependent claims, and a portable computing device (60);

the portable computing device (60) comprises at least one communication antenna (63) and/or a connection port, a memory (62), an interface, and a computing device (61) executing a software application;
the control device of the exercising device is connected to a communication antenna, or a connection port, and is configured to transmit information from the mentioned at least one measuring device to the portable computing device, and wherein
the software application is configured to execute an algorithm to analyze the information supplied by the control device of the exercising device.

15. The system according to claim 14, wherein the portable computing device includes at least one additional measuring device selected from a humidity, temperature, and/or atmospheric pressure sensor, a GPS positioning sensor, an orientation sensor, a time meter configured to determine the time and/or date at which an exercise is performed and/or the duration thereof, and wherein the portable computing device is configured to transmit the information provided by said at least one additional measuring device to the exercising device, and/or to analyze said information together with the information transmitted from the exercising device by the algorithm.

16. The system according to claim 14 or 15, wherein the portable computing device includes a connection to a remote server and is configured for the transmission of the information obtained by the sensor devices and/or additional sensor devices, or for the transmission of the result of the analysis performed by the algorithm to said remote server.

17. A method of determining adhesion for climbing by means of a system such as the one described in any one of preceding claims 14 to 16, wherein the method comprises:

transporting the exercising device to a climbing site;
configuring the exercising device according to predefined adjustment parameters;
performing a grip test by placing a hand in the exercising device, supporting the carpal area of the palm of the hand in the carpal support (20) and the distal phalangeal area of the hand in the distal phalangeal support (30), in the extended grip position, and performing a relative sliding between the carpal support (20) and the distal phalangeal support (30) towards the arched grip position along the travel distance until the distal phalangeal support (30) escapes from the user's hand;
calculating, by means of the algorithm executed by the software application, a climbing performance estimate based on the analysis of the result of the grip test, in relation to stored reference data which correlates the results of the grip tests and climbing performance data.

18. The method according to claim 17, wherein the reference data contains results of the grip tests performed with the same predefined parameters as the grip test to be analyzed.

19. The method according to claim 17 or 18, wherein the predefined adjustment parameters include the placement of a distal phalangeal support (30) defining a frictional distal phalangeal seating on a sagittal distal phalangeal surface mostly facing the sagittal direction (DS), or the use of a surface mostly facing the sagittal direction (DS) of the distal phalangeal support (30) as the frictional distal phalangeal seating.

20. The method according to claim 17, 18, or 19, wherein the point of the travel distance where the escape occurs is determined by the strain sensor, by the movement sensor, or by an analysis performed by the algorithm on the information supplied by the strain sensor and/or by the movement sensor.

21. The method according to claim 17, 18, 19, or 20, wherein the stored reference data also correlates the results of the grip tests and the climbing performance data with stored information referring to existing environmental atmospheric values when and where the grip tests and climbs were performed, and wherein the method further comprises obtaining environmental atmospheric values at the climbing site, calculating the climbing performance estimate considering said measured and stored environmental atmospheric values.

22. The method according to any one of preceding claims 17 to 21, wherein the stored reference data also correlates the results of the grip tests and the climbing performance data with stored information about the geographic location of where the grip tests and climbs were performed, and wherein the method further comprises obtaining values of the geographic

location where the grip test is performed, and calculating the climbing performance estimate by comparing the result of the grip test with stored reference data obtained at the same geographic location, or at an equivalent geographic location with similar climbing conditions.

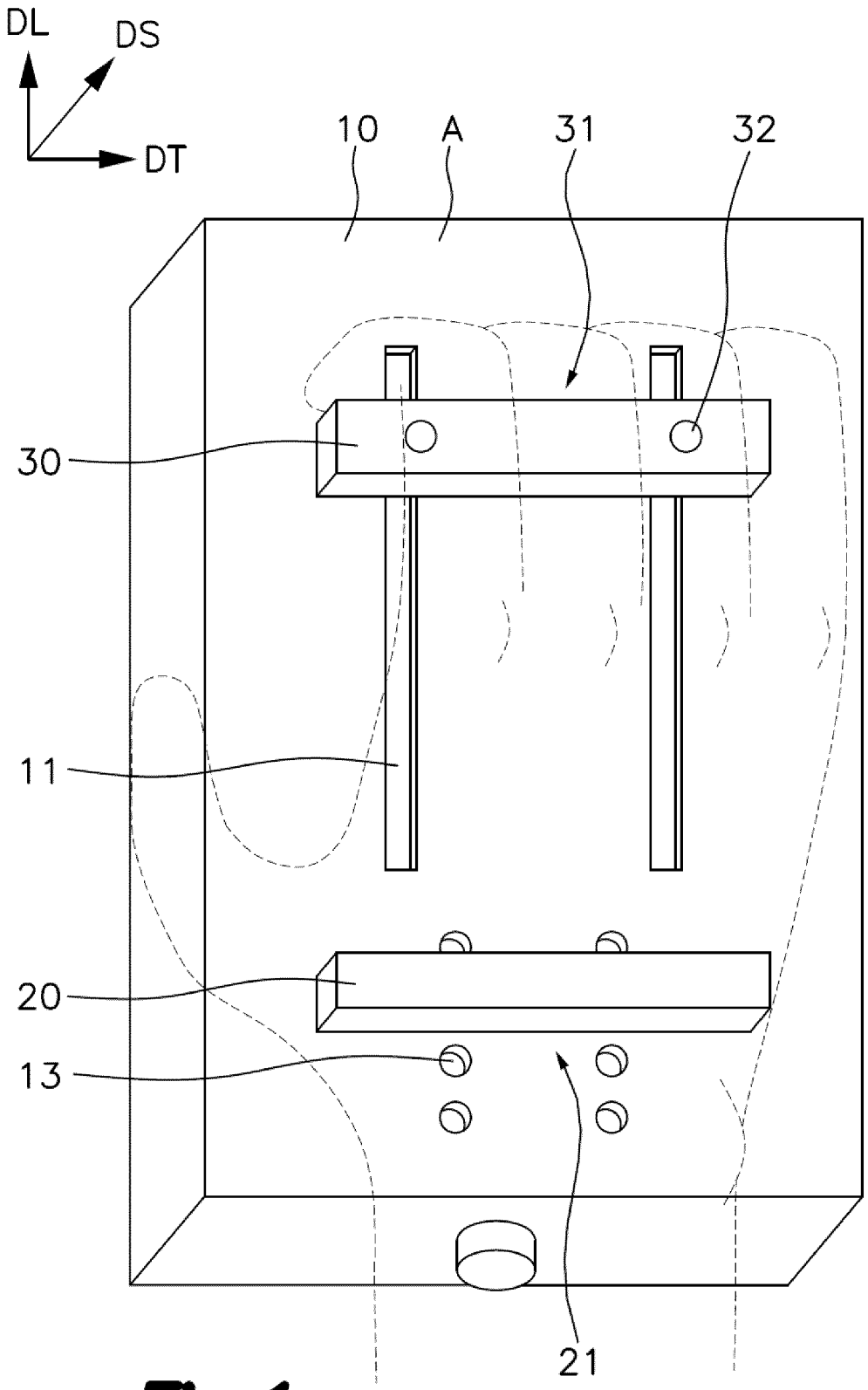

Fig. 1

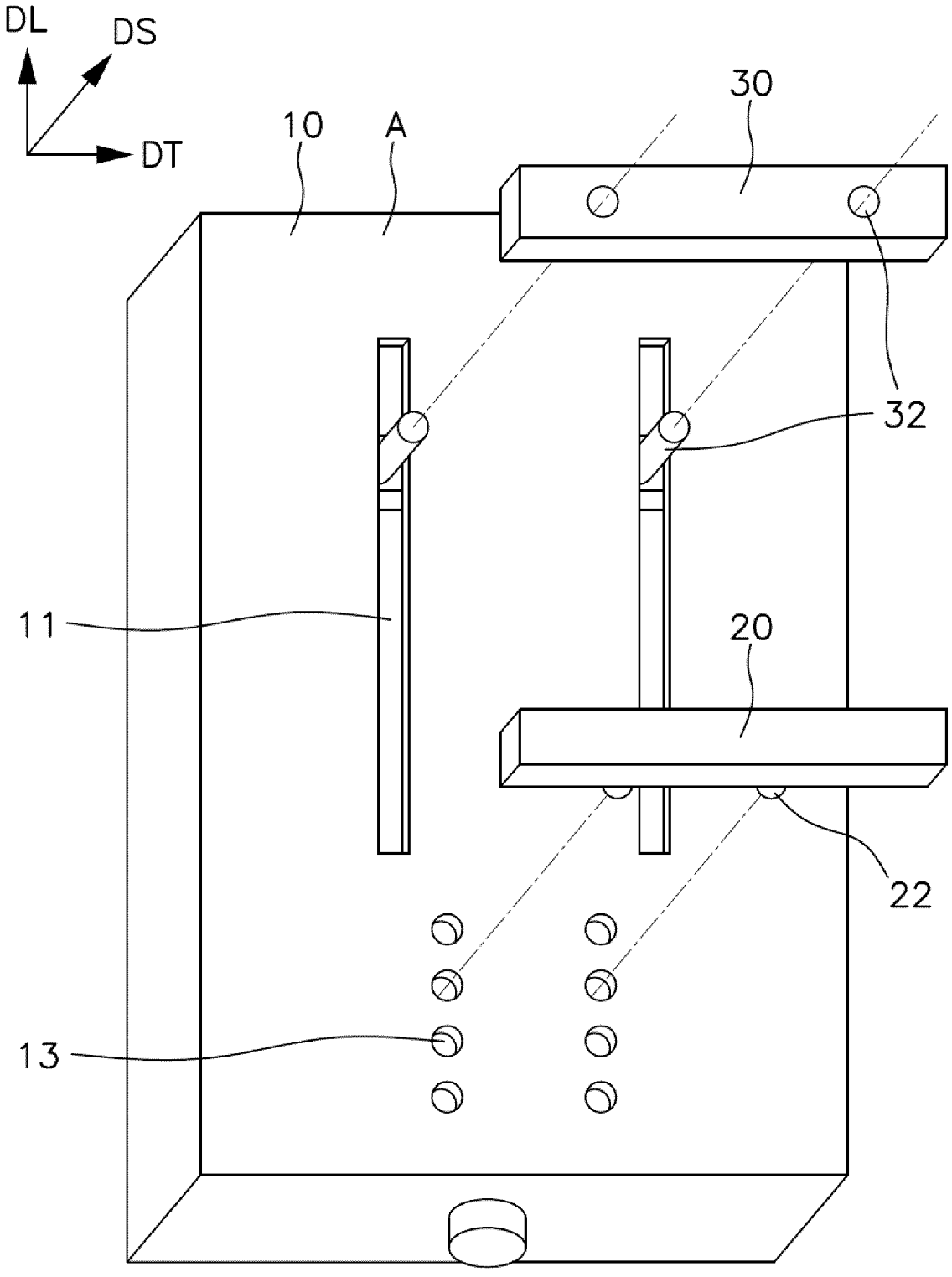

Fig.2

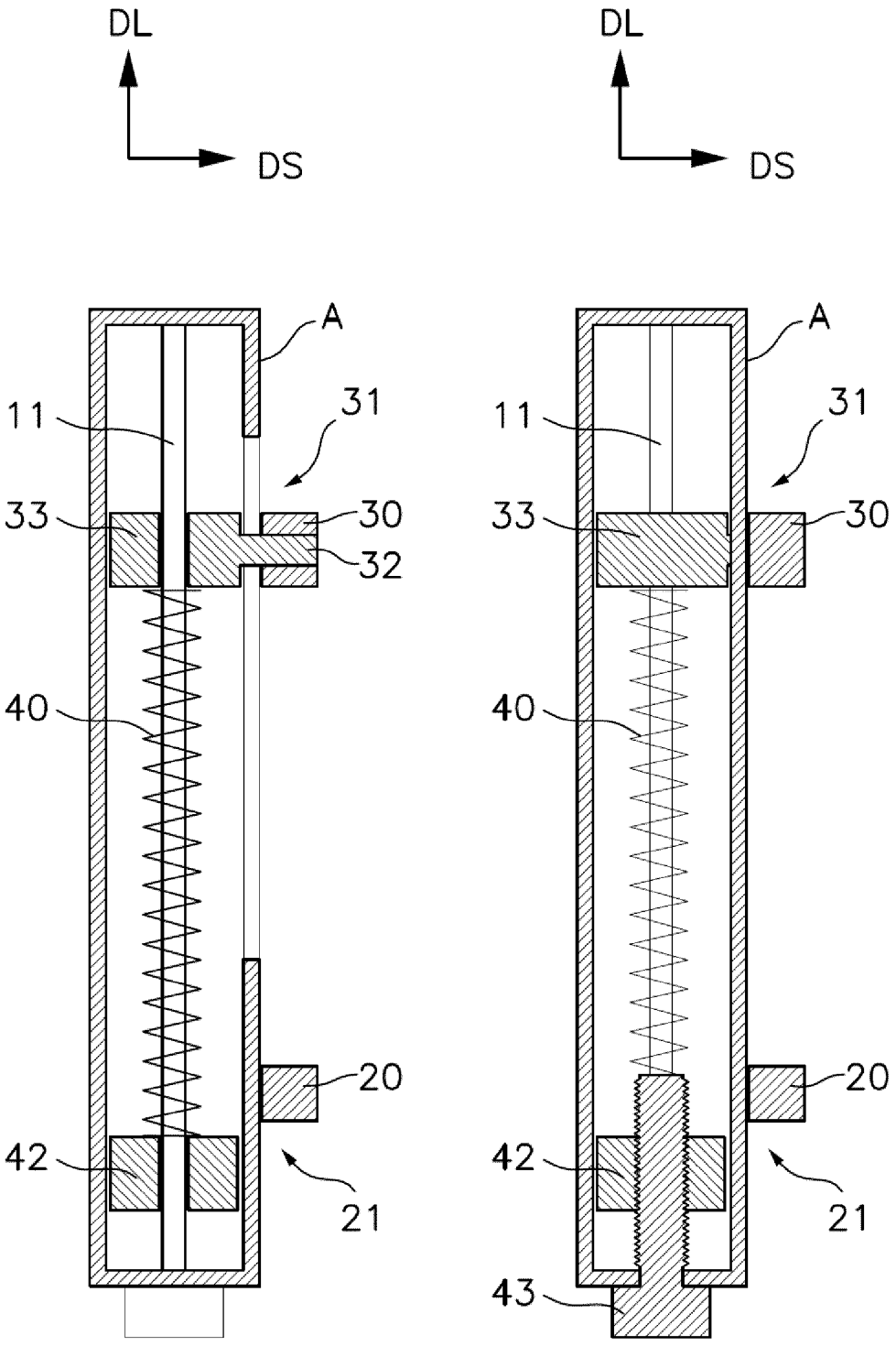

Fig.3

Fig.4

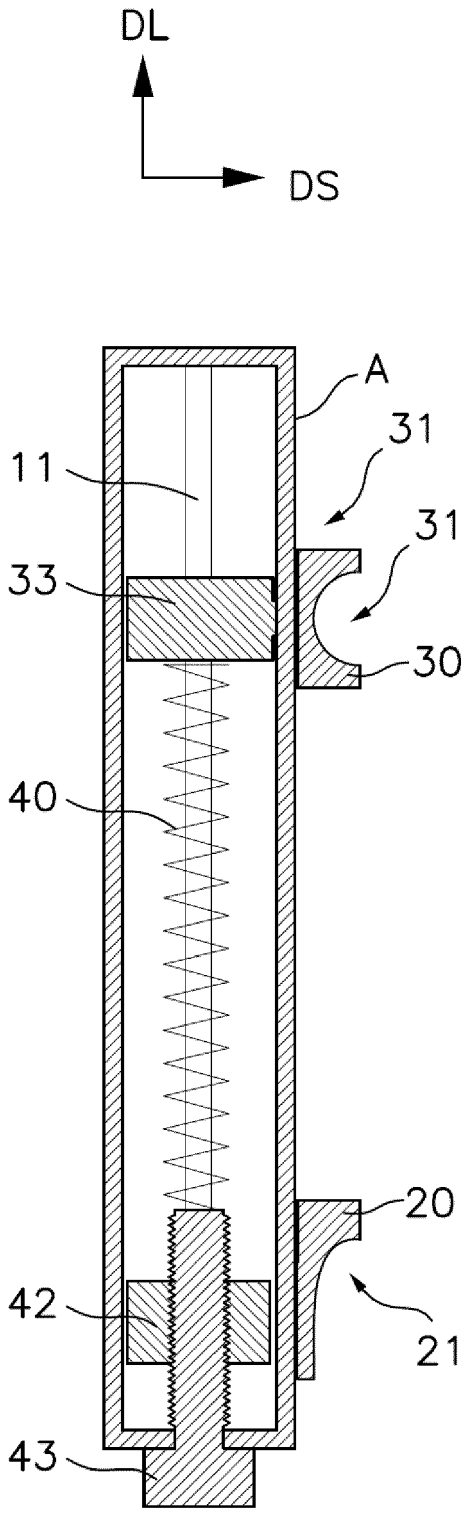

Fig.5

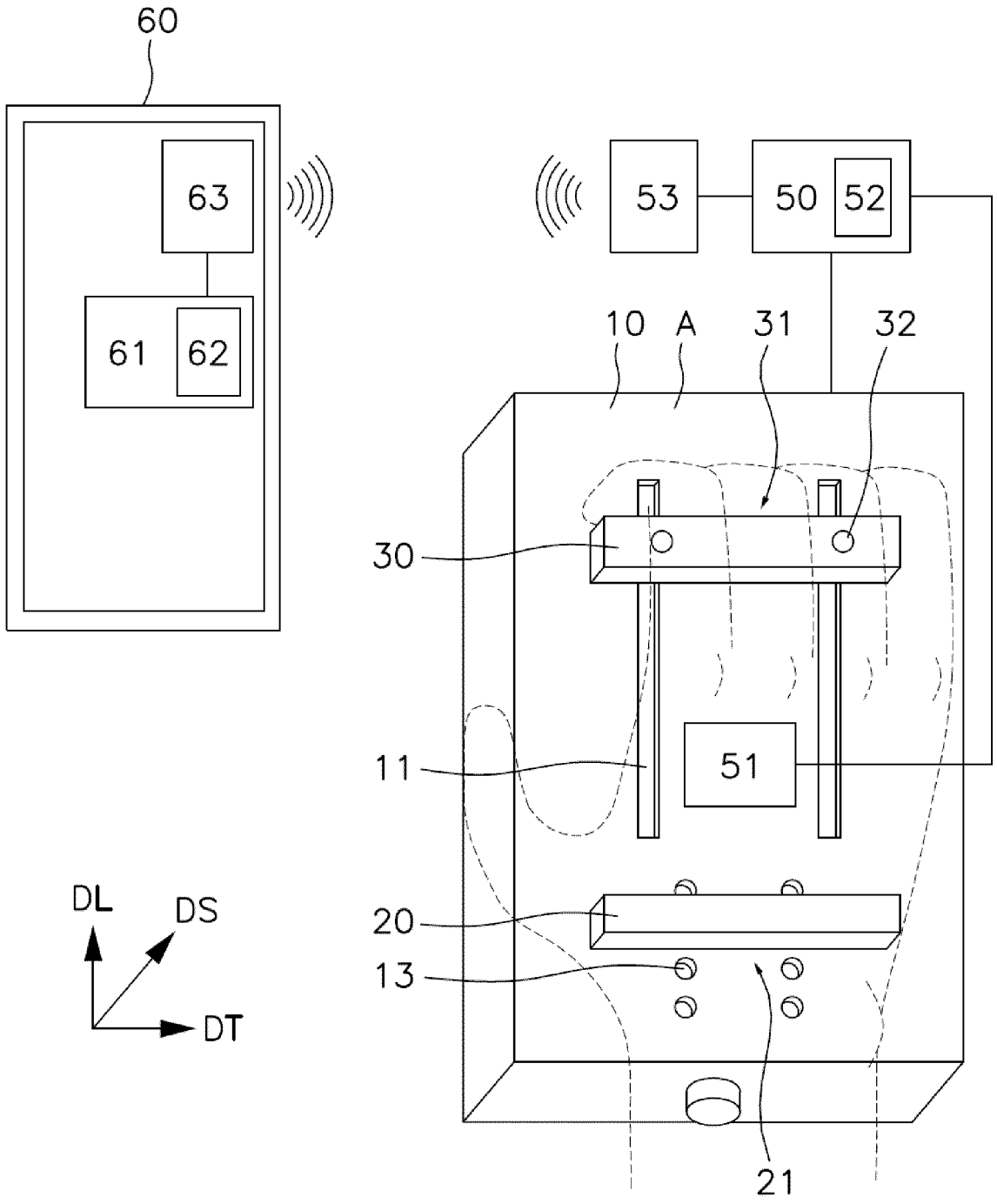

Fig.6

INTERNATIONAL SEARCH REPORT

International application No
PCT/ES2022/070776

A. CLASSIFICATION OF SUBJECT MATTER
INV. A63B69/00
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 2006/123651 A1 (TILLIM STEPHEN L [US]) 15 June 2006 (2006-06-15) paragraph [0096] - paragraph [0098]; figures paragraph [0129] - paragraph [0131]	1,2,7-13
X	US 2016/220863 A1 (BRAIER ROBERT [US] ET AL) 4 August 2016 (2016-08-04) paragraph [0048]; figures paragraph [0050] paragraph [0053] paragraph [0055] paragraph [0058] - paragraph [0059]	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
28 March 2023	05/04/2023

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Squeri, Michele

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/ES2022/070776

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006123651 A1	15-06-2006	US 2004088827 A1	13-05-2004
		US 2006123651 A1	15-06-2006
US 2016220863 A1	04-08-2016	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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- US 689652 A **[0011]**
- WO 2018000412 A **[0011]**
- WO 2017171534 A **[0013]**