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(72) Inventor: **BADEA, Radu Cristian**
Bucharest (RO)

(74) Representative: **Preda, Raluca-Laura**
Rominvent S.A.
35, Ernil Pangratti Str.
1st Floor
Sector 1
011882 Bucuresti (RO)

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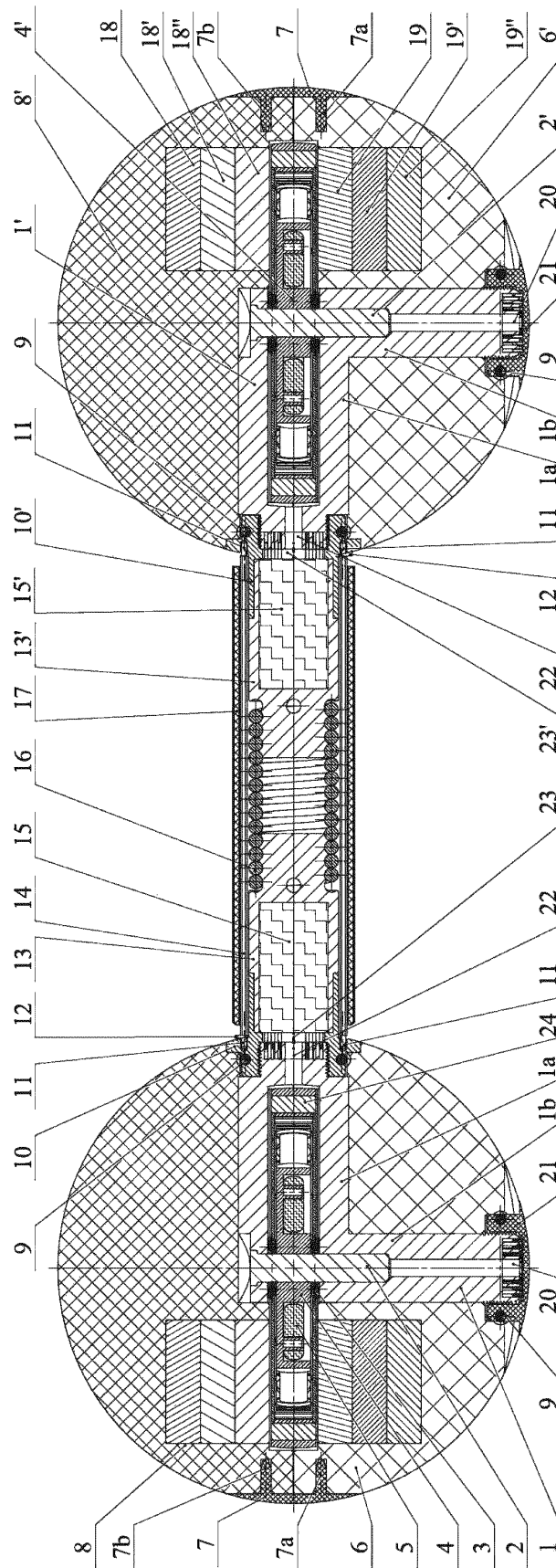
(71) Applicant: **Institutul National de Cercetare**
-Dezvoltare
Pentru Mecatronica Si Tehnica Masurarii-
I.N.C.D.M.T.M. Bucuresti
021631 Bucharest (RO)

(54) **PORTABLE DUMBBELL-TYPE DEVICE FOR DEVELOPING THE LEVEL OF NEUROMUSCULAR CONTROL AND THE MOTRIC PARAMETERS OF THE UPPER LIMBS MUSCULATURE**

(57) Portable dumbbell-type device comprising two weight subassemblies, mounted at one end and at a second end of a handle subassembly, each weight subassembly being configured in the form of an enclosure that includes therein a fork-type body (1, 1') comprising a main arm (1a) and a secondary arm (1b) perpendicular to the main arm, wherein the fork-type body is connected to one of the handle's ends by means of one of the main arm (1a) or secondary arm (1b), an brushless direct-current electric motor (4, 4') comprising a rotor configured in the form of a casing (26) and which can rotate around its own central longitudinal axis and around a stator (27) rigidly mounted on the fork-type body, an electronic control module (5) fixed to the stator, the handle being configured in the form of a longitudinal, substantially cylindrical

profile, which includes two electric batteries (15, 15') that supply an associated motor, each battery being located at one end of the handle, such that the axes of the motors are positioned perpendicular to an axis of the handle or an axis of the first motor is collinear with the axis of the handle and an axis of the second motor is perpendicular to the axis of the handle and the rotation of each rotor is carried out in different planes so that during the operation of the motors, each position of the axis of each motor changes compared to a non-operative position of the device, depending on a direction in which a user translates or rotates the device, generating a precession force generated by the rotation of each rotor, this being perceptible by the user in the form of a complex neuromuscular strain in at least two anatomical planes.

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SECTION A-A

fig.2

Description

[0001] The invention relates to a portable dumbbell-type device for training used for the development of the level of neuromuscular control and the motric parameters of the upper limbs musculature, which implies the simultaneous achievement of the following goals: the exercises performed with the help of this device allow over time, both an increase in strength, speed and endurance of the main muscles responsible for the movements performed by the upper limbs, as well as the development of the auxiliary muscles (the synergistic and the stabilizing ones) involved in the mentioned movements, through the cooperation between all these types of muscles so that in terms of the biomechanics of movements, muscle development and energy consumption involved, an increase in efficiency can be obtained. This device is extremely useful both for usual training and for those required in the case of post-traumatic recovery training in which the main objective is to obtain joint stability, to achieve a biomechanically correct movement, simply put, the development of neuromuscular control followed by the actual biomotric development.

[0002] Many existing devices share similarities, yet they offer only some of the functionalities provided by the current device. To clarify the distinctions between these devices and the proposed invention, they have been classified according to their functions. This classification considers how each device creates the disruptive motion critical for enhancing neuromuscular control stimulation, as well as the directions (planes) in which it manifests, the categories being as follows:

1. Disruptive motion self-generating devices (of destabilizing forces - in which the generation of disruptive movements is achieved without the direct input of the user) and through their use, these devices primarily target the development of the main muscles involved in the movement, with some impact on auxiliary muscles. Specifically, they stimulate synergistic muscles to a limited extent and only in one direction (in one plane), while simultaneously engaging stabilizing muscles. Within this category, depending on the principle on which the disturbance generation is based, the existing devices are categorized as follows:

a. Devices based on the gyroscope principle:
US 5871423 A describes a motorized dumbbell connected to a power source for use in exercising a muscle group of a user. The motorized dumbbell comprises a handle and a weight sub-assembly connected thereto. The weight sub-assembly includes a base connected to the handle and a skirt extending from the base to form a cup-shaped recess. A cover is positioned on a side of the skirt opposite the base to close the cup-shaped recess. A motor is positioned in

the cup-shaped skirt and connected to receive power from the power supply. A disc is rotatably connected to the motor and is set in rotational motion when the motor is connected to the power source. The movement of the motorized dumbbell when the disc rotates produces inertia and gyroscopic forces that act to increase the resistance applied to the muscle group being exercised by the user. A fan is driven by the motor to draw air into the cup-shaped skirt through a plurality of slots extending radially from the base and to direct the air out through a plurality of slots in the circumference of the skirt for providing a cooling effect to the user.

b. Devices based on the vibrator principle with an eccentric element

DE 102010047757 B3 describes a dumbbell with a tubular handle provided with a vibrating device mounted therein. By means of the vibration device, vibrational movements can be transmitted to the dumbbell handle. The present technical solution is characterized in that the vibration device has a first electric motor and a second electric motor, each of which is connected or connectable to the handle of the dumbbell to produce vibrations, and an imbalance component arranged between the first and second electric motors which is rotatable about an axis of rotation, wherein the imbalance component is adjustable in a rotational movement about the axis of rotation of the first and second electric motors to cause vibrating movements of the dumbbell handle;

2. Devices that generate disruptive movements (destabilizing forces) through the user's direct input, facilitating the development of primarily the primary muscles engaged in the action and, to a lesser degree, the secondary muscles. As in the previous case, the synergistic muscles are stimulated to a small extent and only in one direction (in one plane), simultaneously, the stabilizing muscles:

US 2012225758 A1 describes a rotating dumbbell including a handle, two pairs of wheels, and eccentric weight subassemblies rotatably mounted on opposite ends of the handle. Each of the wheels has a pivoted center on the handle and does not allow adjustment in its radial direction. Each of the eccentric weight subassemblies is adjustable in its radial direction. The dumbbell additionally includes two housings that house the two weight subassemblies and respectively, the wheels. Therefore, the user may receive an additional load due to the eccentric rotation of the weight assemblies when he moves the dumbbell. The dumbbell can be used as a roller to exercise the abdominal muscles, while the wheels provide the rolling function.

[0003] Classic dumbbell-type training devices produce the intended effect through the resistance of its specific weight, which the required musculature must overcome. This resisting force is unidirectional and thus the strain is directly addressed to the main (agonist) muscles. The additional strain required to obtain a higher-level involvement of the neuromuscular control system is obtained in the innovative devices presented above by means of destabilizing forces due to the inertia of the mass element in rotational motion, the latter's opposition to the orientation of its axis of rotation, or the vibration produced by the eccentric element in rotational motion. These destabilizing forces increase the level of stress on the neuromuscular control system. It will react by activating the auxiliary muscles responsible for the mechanical stabilization of the joints involved directly and/or indirectly in the movement, a necessary action to preserve joint integrity. Thus, over time, through training with this type of devices, an increase in the level of neuromuscular control can be obtained, in addition to the main effect of developing motor parameters (speed, strength, endurance). The more complex the neuromuscular strain is, the more intense the involvement of the neuromuscular system will be. Neuromuscular involvement is maximal when destabilizing forces act in all anatomical planes. Thus, a more effective control over the muscles will result over time, thus reducing the risk of injury and/or allowing a correct post-traumatic recovery.

[0004] Starting from the elements mentioned in the previous paragraph, the devices listed above, present depending on the category in which they were placed, the following disadvantages:

In the case of devices that self-generate disruptive movements (of destabilizing forces), based on the principle of the gyroscope, they use the precession effect that occurs when a mass element in rotational motion and having a relatively high angular speed opposes changes in orientation of its axis of rotation. With these devices, the plus in terms of increasing the level of neuromuscular strain is primarily due to the inertia of the mass element in rotational motion, which combined with the total weight of the device, produces that resistant force that the user's musculature must overcome. This resistive force, due to the inertia of the rotating mass element, acts only on the main musculature. If the user makes a pronation/supination movement, the precession effect comes into action, with the rotating mass element opposing this hand movement. The resistive force thus created adds up to the inertia and overall weight of the device, increasing the level of strain on the neuromuscular system. This aspect highlights the fact that the destabilizing force caused due to the precession effect can manifest itself at a given moment only in one plane and thus the proposed solution will not allow the maximum involvement of neuromuscular control. The destabilizing force, in this situation, can only be generated if the user performs a pronation/supination movement, i.e. by achieving a torsional moment having the axis perpendicular to the axis of rotation of the

rotating mass. Therefore, the increase in neuromuscular strain through the precession effect is relatively small as it only acts on the musculature responsible for achieving supination/pronation and only if the user rotates their hand.

[0005] In conclusion, the major disadvantage of these inventions is that the disturbance necessary to increase over time the level of neuromuscular control and the activation of agonistic and antagonistic as well as synergistic musculature occurs simultaneously in a single plane (parallel to the sagittal plane), and the one required to activate the stabilizing muscles is simultaneously manifested in a single plane that can be parallel or perpendicular to the sagittal plane. Thus, not all muscle groups that ensure joint stability in all directions can be activated simultaneously, reducing the degree of involvement of the neuromuscular control system and therefore, the expected effect in terms of increasing the level of neuromuscular control becoming relatively small. Also, the selection of the plane in which the disturbance occurs can only be achieved by repositioning the hand in relation to the plane of movement, which leads to the modification of the muscle torque involved in the movement and therefore to the significant reduction of the involvement of the synergistic and stabilizing musculature.

[0006] In the case of devices that self-generate disruptive movements (of destabilizing forces), based on the vibrator principle made with an eccentric element, the disturbance is produced because of the rotation of a mass element eccentrically mounted on the rotor of an electric motor. Devices in this category have the following disadvantages:

- the resulting vibration vector will only move in a plane parallel to the sagittal plane, with 360° during one complete rotation of the eccentric weight. Thus, the vibrations will stimulate only the agonist/antagonist musculature and to a very small extent the synergistic one. They will not stimulate the stabilizing musculature and therefore the impact on the neuromuscular system will be relatively reduced;
- devices containing the vibrating subassembly in the handle have the disadvantage that the amplitude of the vibrations is limited by the inside diameter of the handle and therefore by the radial distance between the central axis of the dumbbell and the center of mass of the eccentric weight. The space available also limits the mass of the eccentric weight and this is important for the vibration force;
- devices that fall into the subcategory of those that can be attached to another device/training system, have as a major disadvantage that, by mounting them on a portable dumbbell-type training device, its overall size will be significantly modified, also requiring the modification of the dumbbell so that the assembly thus formed can be usable and can perform its complex function in training. If mounted on a stationary training system, the obvious disadvantage

vantage is the lack of portability. Another disadvantage of attachable devices is that the resulting vector of vibration will only move in a plane perpendicular to the axis of the handle. Thus, the vibrations will stimulate only the agonist/antagonist musculature and to a very small extent the synergistic one. They will not stimulate the stabilizing musculature and therefore the impact on the neuromuscular system will be relatively reduced.

[0007] In the case of devices in which the generation of disruptive movements (destabilizing forces) is carried out with the direct input of the user, the main disadvantage of this technical solution is that the vibration is produced by means of a specific movement (necessary to set the eccentric weights in motion directly proportional with the composed velocity of the flexion/extension movement at the elbow joint and the flexion/extension movement at the shoulder joint) performed by the user. This fact predisposes the user to the generation of a stabilizing neuromuscular reaction whose duration of action is limited by the duration of execution of the specific movement, which does not correspond to the duration of actual use of the dumbbell. The main disadvantage of this invention is that the generation of the disturbing force is also carried out by the user, which implies the use of additional muscle groups necessary to maintain the rotation of the eccentric weights responsible for producing the imbalance. This is achieved by transforming the stabilizing musculature into the agonist/antagonist musculature and with additional energy consumption. This type of training is not recommended in certain situations, such as the one where the user has a shoulder joint in a post-traumatic situation, or just weakened, in which case it is recommended to first develop the stabilizing function of the upper limb and then develop the biometric parameters.

[0008] Regardless of the proposed solution, the devices presented above do not require the simultaneous involvement of the musculature on all three anatomical planes and thus, the increase in the level of neuromuscular control will be relatively small, this being obtained at the expense of joint stability, thus resulting an increase of risk of injury.

[0009] The purpose of the present invention is to provide the user with a portable device, through the use of which over time it is possible to obtain a maximum increase in the level of neuromuscular control of the upper limbs, due to the effective cooperation between the main and the auxiliary musculature, the latter being represented by all the musculature groups responsible for the complete stabilization of the joints involved and by the synergistic musculature, in other words, it is about the muscles that act in all three anatomical planes. With this maximum increase in the level of neuromuscular control, there is an increase of efficiency of biometric actions, a harmonious development of the musculature involved and optimization of energy consumption, simultaneously

with the development of motor parameters (speed, strength, endurance) and with the correction of the biomechanics of movements.

[0010] The technical problem that this invention solves is to provide the user with a portable dumbbell-type device that allows the development of not only the main musculature, but also the auxiliary musculature, by simultaneously generating destabilizing forces in all three anatomical planes (frontal, sagittal and transversal), thus obtaining an effective cooperation between all types of musculature, which allows training in safe conditions and with a higher level of energy efficiency, which are extremely important elements in the training process of athletes, and also during the sessions of post-traumatic recovery.

[0011] According to specialized literature, depending on the ways in which the musculature groups act, these can be categorized as follows:

- a. The main musculature - is the one directly responsible for making the movement and is represented by the agonist muscles;
- b. The auxiliary musculature is composed of:
 - synergistic musculature - is that which can be recruited to help the main musculature in overcoming a higher-level strain;
 - the stabilizing musculature - is the one that ensures the stability of the anatomical structures involved in the movement, so that the movement performed is correct from a biomechanical point of view, thus increasing the efficiency of the main musculature and reducing the risk of injury.

[0012] For example, in the case of a flexion/extension movement of the elbow, involved in the training action of the brachial biceps musculature, the latter represents the agonist muscle (representing the main musculature responsible for the flexion movement of the elbow, the extension being performed without the contraction of the brachial triceps due to gravitational force), the brachioradialis muscle represents the synergistic musculature (contracting together with the brachial biceps to achieve elbow flexion), and the brachial triceps, the muscles of the forearm and with the muscles of the rotator cuff represent the stabilizing musculature (this ensuring the functional integrity of the joints involved in weight lifting, by supporting the joint ligaments and by maintaining the correct trajectory of the flexion movement so that no unwanted movements will occur in the involved joints). Through the effective combined effort of all these types of musculature, the resulting movement is performed with maximum efficiency and is correct from a biomechanical point of view, thus reducing the risk of injury due to musculature overload and/or joint strain in incorrect directions from a biomechanical point of view.

[0013] The neuromuscular system is that component of the nervous system, which receives and analyzes the

signals received by the body's sensors and sends commands to the motric units, resulting in adaptation reactions of the body to the environment. Neuromuscular control is defined by the control exercised by the central nervous system over the activity of the skeletal musculature, resulting in an adjustment of the movement that allows the achievement of correct joint statics/dynamics from a biomechanical point of view and efficiency from an energetic point of view (achieved with minimum effort and with maximum comfort). The more musculature groups (main, synergistic, and stabilizing) are involved in making a movement, the more the neuromuscular control system is strained. This strain over time produces an increase in the level of neuromuscular control. Optimal joint stabilization is achieved by involving the auxiliary musculature that act in all anatomical planes: frontal, sagittal and transversal. Training has the effect of creating neuromotor connections, and a correct training leads to their optimization. The optimized neuromotor connections allow for movements with reduced energy consumption and eliminate the risk of injury, because the involved joints are protected by the involvement of the auxiliary musculature in all three anatomical planes, thus performing only those correct movements from a biomechanical point of view. In the absence of the involvement of the musculature acting in one of the three anatomical planes, the strained joints are incompletely stabilized, thus increasing the risk of injury, due to the resulted incorrect movements, from a biomechanical point of view.

[0014] The portable dumbbell-type device for developing the level of neuromuscular control and the motric parameters of the upper limbs musculature of a user according to claim 1 comprises two weight subassemblies, mounted at a first end and respectively at a second end of a handle subassembly,

- each weight subassembly being configured in the form of an enclosure, which includes therein;
- a fork-type body comprising a main arm having an "U" shape and a secondary arm perpendicular to the main arm, wherein the fork-type body is connected to one of said handle subassembly's ends by means of one of the main or secondary arms;
- a brushless direct-current electric motor comprising a rotor configured in the form of a casing and which can rotate around its own central longitudinal axis and around a stator rigidly mounted, by means of a shaft, on the fork-type body;
- an electronic control module fixed to the stator;
- the handle subassembly being configured in the form of a longitudinal, substantially cylindrical profile, comprising therein two electric batteries that respectively supply an associated electric motor, each electric battery being located at one end of the handle subassembly,

characterized in that

the longitudinal central axes of the two electric motors are positioned:

- perpendicular to a central longitudinal axis of the handle subassembly or
- a longitudinal central axis of the first electric motor is collinear with the longitudinal central axis of the handle subassembly and a longitudinal central axis of the second electric motor is perpendicular to the longitudinal central axis of the handle subassembly and

the rotation of each rotor of the two electric motors are made in different planes such that during the operation of the electric motors, each position of the longitudinal central axis of each electric motor changes compared to a non-operative position of the device, according to a direction in which a user translates or rotates the portable dumbbell-type device, generating a precession force generated by the rotation of each rotor, this force being perceptible by the user in the form of a complex neuromuscular load in at least two anatomical planes.

[0015] Portable device for developing the level of neuromuscular control and the motric parameters of the upper limbs musculature, according to the present invention, in relation to the proposed constructive embodiment, is made in the form of a dumbbell containing two weight subassemblies mounted on one side and the other of the handle subassembly, at its ends and comprises: two fork bodies, two shafts, four radial bearings, two electric motors, each having an electronic control module, two lower weight covers, six locking bodies, two upper weight covers, four anti-rotation bodies, two end bodies, eight guide pins, two anti-expansion bodies, two left and right handle bodies, two upper and lower handle bodies, two electric batteries, one extension spring, one elastic sleeve, two upper sets of weights, two lower sets of weights, two secondary connectors, two connector caps, two main connectors, two left and right handle connectors, two sets of eccentric weights, eight guide bushing.

[0016] The two weight subassemblies of the proposed device are identical, being made up of the following components, listed above: one of the fork bodies, one of the shafts, two of the radial bearings, one of the electric motors, one of the electronic control modules, one of the lower weight covers, three of the locking bodies, one of the upper weight covers, two of the anti-rotation bodies, one of the two upper sets of weights, one of the two lower sets of weights, one of the secondary connectors, one of the connector covers, one of the main connectors, one of the sets of eccentric weights, four of the guide bushing. The electric motor is a brushless direct-current (BLDC) electric motor with the rotor in the housing (of the type used in hoverboards, electric scooters or skateboards,

where the wheel is mounted on the motor housing, this performing the function of motor rotor). The electric motor comprises a casing with four arc-shaped slots (cavities), in which the four eccentric weights can be fitted, a stator, the electronic control module and a protection cover for the electronic module. The stator is mounted rigidly, via the spindle, to the fork body and contains the electronic control module. The two lower and respectively upper weight covers are made of an elastic material (rubber-type with high density and hardness) and have internal recesses that allow both their rigid fixation on the fork element and the free rotation of the electric motor housing. The previously mentioned covers are held in position by means of three locking bodies, each having two legs mounted with friction in the special recesses provided in the two covers and an anti-rotation body, mounted with the extremities, by means of a guide bush. The latter are rigidly mounted one in the lower weight cover and the other in the upper weight cover. Also, the lower weight cover has four conical pins that correspond to circular bores made in the upper weight cover. By means of the previously mentioned elements, a pre-guidance necessary for the correct and quick assembly of the two weight covers is obtained. The lower and upper weight covers each have a pair of recesses made to allow easy extraction of the weights from the two sets: the lower and respectively the upper one. The fork body comprises the main arm, on the end of which the main connector is mounted, and respectively the secondary arm, perpendicular to the main one, on the end of which the secondary connector is mounted, which is protected by means of a connector cover. The main arm of the fork body has the shape of the letter "U" in the front section, allowing both the correct positioning of the electric motor and the free rotation of its body. The outer faces of the two main and secondary arms are threaded to allow their threaded fitting onto the handle subassembly.

[0017] The handle subassembly, of the proposed device, in one embodiment, comprises the following elements mentioned above: the end bodies, eight directional pins, the two anti-expansion bodies, the two left and right handle bodies respectively, the two upper and lower handle bodies, the two electric batteries, the extension spring, the elastic sleeve and respectively the two left and right handle connectors. The end bodies are rigidly mounted on the two left and right handle bodies, inside which the electric batteries (accumulator type) are located and which are elastically connected to each other by means of the extension spring. The latter has its ends inserted into a particular diametrical bore provided in each of the two left and right handle bodies, on which it is mounted by screwing, the extension spring also having the role of keeping in contact the two previously mentioned bodies. The electric batteries are electrically connected to the left and respectively right handle connectors. The two upper and lower handle bodies are located above the two left and right handle bodies respectively, the latter being covered in the elastic sleeve. The two

upper and lower handle bodies, respectively, have a circular cross-section and are constructed in such a way that when they are lightly pressed on the left and respectively right handle bodies, they can slide freely on the latter, and an interstice is provided between the lateral faces of the two handle bodies. On the ends of each of the two upper and lower handle bodies, the pins are mounted rigidly, on one side and the other of the longitudinal plane of symmetry. The latter have their free ends slidably mounted in the pairs of slots provided in the end bodies and respectively have several roles: to guide the movement of the two upper and lower handle bodies respectively when they approach or move away from the two left respectively right handle bodies and, to block the rotation of the two upper and lower handle bodies respectively in relation to the left and respectively right handle bodies and to allow blocking the movement of the two handle bodies, when one body is mounted at each end of the handle subassembly an anti-expansion body on each pair of pins. This pair comprises a pin belonging to the upper handle body and one pin belonging to the lower handle body, these being on the same side in relation to the longitudinal plane of symmetry of the handle assembly. On the outer ends of the left and right handle bodies, two pairs of circular slots are made, with their axes of symmetry perpendicular to each other. Each of these pairs is composed of circular slots whose axes of symmetry are parallel to each other, are symmetrical in relation to the longitudinal plane of symmetry of the handle subassembly and parallel to the outer faces of the left and right handle bodies. By inserting the anti-rotation body into a pair of such slots, the rotation is blocked during use of the proposed invention of the weight subassemblies relative to the handle subassembly, onto which they were previously mounted by screwing.

[0018] When the electrical contact is made between the connectors of the weight subassemblies and those of the handle subassembly, formed after mounting the weight subassemblies on the handle subassembly, the electronic control modules are electrically powered. The electric motors are powered by means of the electronic control modules, from the corresponding electric battery, which is a rechargeable battery type. The electric batteries are charged by means of the corresponding handle connector, which connects to a paired connector, belonging to an external battery charging system.

[0019] The portable device for developing the level of neuromuscular control and the motor parameters of the muscles of the upper limbs, according to the invention, in relation to existing solutions presents the following advantages:

- allows the development of speed, strength, and endurance of the upper limb, as well as neuromuscular control at the level of this limb;
- allows the generation of the destabilizing force in all three anatomical planes, thus obtaining a maximum involvement of the neuromuscular control system;

- allows the development of the level of neuromuscular control by stimulating the involvement of all musculature groups, both the main ones and the auxiliary ones;
- allows the stimulation of auxiliary musculature groups in all three anatomical planes: frontal, sagittal and transversal;
- the device is portable and works independently of other devices and/or systems;
- for muscle development, the proposed device allows the user to opt for both the gyroscopic principle and the perturbation principle produced by the rotational movement of an eccentric mass element. The use of the two principles can be carried out simultaneously or independently;
- allows the efficient development of the musculature due to the possibility of simultaneous use of the gyroscopic principle and the principle of perturbation produced by the rotational movement of an eccentric mass element;
- in the case of using the principle of perturbation produced by the rotational movement of an eccentric mass element, the proposed device allows changing the amplitude of the vibration, a fact that produces a change in the level of strain (to which the user's musculature is subjected) and a change in the frequency of the vibration, this action producing the change of intensity of the strain (to which the user's musculature is subjected);
- in the case of using the gyroscopic principle, the proposed device allows the precession effect to be achieved simultaneously in two planes perpendicular to each other. Basically, in this situation, one of the moving mass elements rotates in a plane and the second one rotates in a plane perpendicular to the first;
- in the case of using the gyroscopic principle, the proposed device allows for a strain increase by generating the precession effect simultaneously in two parallel planes. Basically, in this situation the two moving mass elements rotate in the same plane;
- regardless of the principle used, the proposed device allows the modification of the musculature strain produced, by using mass elements made of different materials, or by using a different number of such mass elements;
- allows easy modification of the total weight of the device;
- allows easy modification of the eccentric weights of the device, in the case of using the principle of precession produced by the rotational movement of an eccentric mass element;
- the use of the proposed device is independent of other devices/systems;
- also allows the development of the flexor muscles of the fingers;
- setting the modes of use (of the operating principles) is easy and does not require the use of external tools

- (that do not belong to the device);
- in the case of the simultaneous use of two such devices, one for each of the two upper limbs, regardless of the principle and function that is chosen, through the differentiated control of their operating parameters, a personalized training, specific for each upper limb, can be carried out, when this is required.

[0020] Below are presented some embodiments of the present invention in connection with figures 1-14, which represent:

fig.1 - front view of the device, with parallel motor axes;

fig.2 - view in longitudinal section of the device;

fig.3 - frontal view of one of the two weight subassemblies of the device, with the lower weight cover 6 removed;

fig.4 - front view of one of the two weight subassemblies of the device, with the lower weight cover 6 and the electronic module protection cover 28 removed;

fig.5 - cross-sectional view of the device, made at the level of the anti-expansion body 12;

fig.6 - cross-sectional view of the device, made at the level of the anti-rotation body 9;

fig.7 - front view of the handle subassembly of the device;

fig.8 - cross-sectional view of the handle subassembly, of the device, made to highlight the blocking mechanism of the movement of the two upper handle body 14 and respectively lower handle body 14', of the handle subassembly;

fig.9 - cross-sectional view of the handle subassembly of the device, made to highlight the shape of the elastic sleeve 17 and the position of the two upper and lower handle bodies 14 and respectively 14', when the movement of the latter is blocked;

fig.10 - frontal view of the device with the motor axes perpendicular to each other;

fig.11 - front view of the device, during use without the movement blocking mechanism of the two upper and lower handle bodies 14 and respectively 14' of the handle subassembly;

fig.12 - frontal view of the handle subassembly, of the device, with a sectional view at the level of the extension spring 16;

fig.13 - cross-sectional view of the handle subassembly of the device in an extreme position in terms of the movement of the two upper and lower handle bodies 14 and respectively 14'.

fig. 14 - front views (figures 14a1, 14b1, 14c1, 14d1) and perspective views (figures 14a2, 14b2, 14c2, 14d2) of the various preferred embodiments of the invention in which the longitudinal central axes of the motors 4, 4' are placed perpendicular to the central longitudinal axis of the handle subassembly (figures 14a1-2, 14b1-2) or the central longitudinal axis of the

first motor 4 is perpendicular to the central longitudinal axis of the handle subassembly and the central longitudinal axis of the second motor 4' is collinear with the central longitudinal axis of the handle subassembly (figures 14c1-2) or the central longitudinal axes of the motors 4, 4' are collinear with the central longitudinal axis of the handle subassembly (figures 14d1-2) and the rotation of each rotor of the motors 4, 4' is carried out in different parallel planes or non-parallel.

[0021] The portable dumbbell-type device for developing the level of neuromuscular control and the motor parameters of the upper limbs musculature, according to an embodiment of the invention, is built in the form of a dumbbell containing two weight subassemblies mounted on either side of a handle subassembly, on its ends (see fig.1) and is composed of: two fork bodies (1, 1'), two shafts (2, 2'), four radial bearings 3, two electric motors (4, 4'), each of which having one electronic control module 5, two lower weight covers (6, 6'), six locking bodies 7, two upper weight covers (8, 8'), four anti-rotation bodies 9, two end bodies (10, 10'), eight directional pins 11, two anti-expansion bodies 12, two bar bodies, left 13 and respectively right 13', two upper handle bodies 14 and respectively lower 14', two electric batteries (15, 15'), an extension spring 16, one elastic sleeve 17, two upper sets of weights (18, 18', 18"), two lower sets of weights (19, 19', 19"), two secondary connectors 20, two connector caps 21, two main connectors 22, two handle connectors, left 23 and respectively right 23', two sets of eccentric weights (24, 24', 24", 24""), eight guide bushings 25 (see fig.2).

[0022] The two fork bodies 1, 1' are identical, the two electric motors 4, 4', are identical, the two lower weight covers 6, 6' are identical and the two upper weight covers 8, 8' are also identical.

[0023] The two weight subassemblies of the proposed device are identical, being composed of the following components, listed above: one of the fork bodies 1, 1', one of the shafts 2, 2', two of the radial bearings 3, one of the electric motors 4, 4', one of the electronic control modules 5, one of the lower weight covers 6, 6', three of the locking bodies 7, one of the upper weight covers 8, 8', two of the anti-rotation bodies 9, one of the two upper sets of weights (18, 18', 18"), one of the two lower sets of weights (19, 19', 19"), one of the secondary connectors 20, one of the connector caps 21, one of the main connectors 22, one of the sets of eccentric weights (24, 24', 24", 24""), four of the guide bushings 25 (see figures 3-5). The electric motor 4, 4' is a brushless direct current (BLDC) electric motor with the rotor in the housing (of the type used in hoverboards, electric scooters or skateboards, where the wheel is mounted on the motor housing, this fulfilling the function of the motor rotor). Each electric motor (4, 4') is composed of a casing 26 that presents four slots (26a, 26b, 26c, 26d) having a circular section placed on a circle which is concentric with the

central longitudinal axis of each electric motor (4, 4') and angular equidistant, inside which at least one eccentric weight (24, 24', 24", 24"" can be friction fitted, a stator 27, the electronic control module 5 and a protective cover 28 of the electronic module. The stator 27 is rigidly mounted, by means of the shaft 2 or 2', to the fork-type body 1 or 1' and comprises the electronic control module 5 (see figures 2-4). The two lower weight covers 6, 6' and the two upper weight covers 8, 8' are made of an elastic material (rubber type with high density and hardness) and have internal clearances that allow both their rigid fixation on the fork-type body 1, 1' as well as the free rotation of the casing 26 of the electric motors 4, 4'. The previously mentioned covers are kept in position by means of three locking bodies 7, which each have two legs 7a and 7b mounted with friction in the special recesses provided in the two covers (see figures 1-2 and fig. 4) and an anti-rotation body 9, mounted with their ends 9a and respectively 9b, through a guide bush 25 (see fig.5). The latter are rigidly mounted, one in the lower weight cover 6, 6' and the other in the upper weight cover 8, 8' (see fig.5). Also, the lower weight cover 6, 6' has four conical legs (6a, 6b, 6c, 6d) which correspond to circular bores (8a, 8b, 8c, 8d) made in the upper weight cover 8, 8' (see fig.5). By means of the previously mentioned elements, a preguiding necessary for the correct and quick assembly of the two weight covers is obtained. The lower weight covers 6, 6' and the upper weight covers 8, 8' each have a pair of bores (6e, 6f) and (8e, 8f) made to allow easy extraction of the weights from the two sets, lower (19, 19', 19") and respectively upper ones (18, 18', 18"). The fork-type body 1, 1' is composed of the main arm 1a, on the end of which the main connector 22 is mounted, and respectively of the secondary arm 1b, perpendicular to the main one 1a, on the end of which the secondary connector 20 is mounted, which is protected by a connector cap 21 (see fig.2). The arm 1 of the fork-type body 1, 1' has in the frontal section the shape of the letter "U" allowing both the correct positioning of the electric motor 4, 4' and the free rotation of its casing 26 (see fig. 10). The outer faces of the two arms 1a and 1b are threaded to allow their screw-on mounting to the handle subassembly. Each weight subassembly also includes an upper set of weights (18, 18', 18") and/or a lower set of weights (19, 19', 19"), preferably mounted on an upper weight cover (8, 8') and/or respectively on a lower weight cover (6, 6').

[0024] The handle subassembly, of the proposed device, is composed of the following elements mentioned above: the end bodies 10, 10', the eight directional pins 11, the two anti-expansion bodies 12, the two bar bodies, left 13 and respectively the right 13', the two upper handle body 14 and respectively lower handle body 14', the two electric batteries 15, 15', the extension spring 16, the elastic sleeve 17 and the two handle connectors, left 23 and respectively right 23' (see fig.2, figures 7-9). The end bodies 10, 10' are rigidly mounted on the two bar bodies, left 13 and respectively right 13', inside which the electric batteries 15 (accumulator type) are located and which

are elastically connected to each other by means of the extension spring 16 (see fig. 2 and fig. 12). The latter has its ends inserted in a diametrically opposite bore, namely provided in each of the two bar bodies left 13 and respectively right 13', on which it is mounted by screwing, the extension spring 16 also having the role of keeping in contact the two aforementioned bodies. The electric batteries 15, 15' are electrically connected with the left handle connector 23 and respectively right handle connector 23'. The two upper and lower handle bodies 14 and respectively 14' are placed over the two bar bodies, left 13 and respectively right 13', the latter being covered in the elastic sleeve 17 (see fig. 2 and fig. 10). The two upper and lower handle bodies 14 and 14', have a circular cross-section and are constructed in such a way that when they are lightly pressed on the left and right bar bodies 13 and 13', they can slide freely on the latter and an interstice is provided between the lateral faces of the two handle bodies 14, 14' (see fig. 10). On the ends of each of the two upper and lower handle bodies 14 and 14' respectively, the pins 11 are mounted rigidly, on one side and the other of the longitudinal plane of symmetry (see fig. 2). The latter have their free ends slidably mounted in the pairs of strait slots (10a, 10b) and (10'a, 10'b) provided in the end bodies 10, 10' (see fig. 6, fig. 8) and have many roles: to guide the movement of the two upper handle bodies 14 and respectively lower 14' when they approach or move away from the two bar bodies, left 13 and respectively right 13', to block the rotation of the two upper handle bodies 14 and respectively lower 14' in relation to the left bar bodies 13 and respectively right 13' and to allow blocking the movement of the two handle bodies 14, 14' when an anti-expansion body 12 is mounted at each end of the handle subassembly on a pair of pins 11. This pair 11 comprises a pin belonging to the upper handle body 14 and another pin belonging to the lower handle body 14', these being on the same side in relation to the longitudinal plane of symmetry of the handle assembly (see fig. 8). On the outer end of the two end bodies 10, 10', two pairs of strait slots are made (10c, 10d) and (10e, 10f), respectively (10'c, 10'd) and (10'e, 10'f), having the axes of symmetry perpendicular to each other (see fig. 7). Each of these pairs is composed of strait slots whose axes of symmetry are parallel to each other, are symmetrical in relation to the longitudinal plane of symmetry of the handle subassembly and parallel to the outer faces of two end bodies 10 and 10' respectively. By inserting the anti-rotation body 9 in a pair of such slots (see fig. 5) the rotation during the use of the proposed invention of the weight subassemblies relative to the handle subassembly, on which they were previously mounted by screwing, is blocked.

[0025] When the electrical contact is made between the pairs of connectors (22, 23), (20, 23), (22, 23'), or (20, 23') formed as a result of mounting the weight subassemblies on the handle subassembly, the electronic module control unit 5 is electrically powered. The electric motors 4, 4' are powered by means of the electronic

control modules 5 from the corresponding electric battery, which is a rechargeable-type battery. The charging of the electric batteries 15, 15' is achieved by connecting the handle connectors 23 and 23' to a pair of corresponding connectors belonging to an external battery charging system.

[0026] In a preferred embodiment of the invention, the handle subassembly also includes: a left bar body 13 and a right bar body 13' located inside the handle subassembly each having a first extremity rigidly fixed to an end body 10, 10' associated, each located at one end of the handle subassembly and each connected to an associated weight subassembly, an extension spring 16 located inside the handle subassembly and connecting a second end of the left bar body 13 to a second end of the right bar body 13', an upper handle body 14 and a lower handle body 14' arranged so that the bar bodies 13, 13' and the extension spring 16 are enclosed within them, an elastic sleeve 17 which surrounds the upper handle body 14 and the lower handle body 14' and keeps the two bar bodies 13, 13' permanently in contact at rest, so that during the operation of the portable dumbbell-type device, the mentioned upper and lower handle bodies 14, 14' can move independent of each other due to the movement of the bar bodies 13, 13' under the combined action of the movements performed by the user and the rotation of each rotor.

[0027] Before starting to exercise with the proposed device, the user will have to opt for one of the following modes of operation of the invention, this option being dependent on the ultimate objective of the training, namely:

- The mode of operation in which the central longitudinal axes of the electric motors of the two weight subassemblies are collinear with each other and collinear with the central longitudinal symmetry axis of the handle, and the operation is based on the gyroscopic principle. This regime is intended for the type of training in which the main objective is to correct the biomechanics of the movement, the device in question opposing the change in the position of the longitudinal central axis of rotation of the electric motors 4, 4'. In the case of carrying out a training intended for the flexor muscles of the elbow (brachial biceps), the device will allow maintaining the correct trajectory of the movement, opposing possible pronation/supination movements, which could produce an overload of the brachial biceps, in case of supination of the hand, due to limiting the action of the brachioradialis muscle, or overstraining the latter and forcing the elbow joint in a biomechanically incorrect direction in case of supination of the hand. Through the opposition achieved by the device in question, in addition to the development of the main musculature, represented by the biceps brachii, a development of the auxiliary musculature, represented by the supinator/pronators of the fore-

arm and the triceps brachii, will also be obtained, due to their tensioning necessary to maintain the correct position of hand and respectively to ensure controlled extension of the elbow. Thus, articular stability is ensured at the level of the elbow and partially at the level of the hand;

- The mode of operation in which the central longitudinal axes of the electric motors 4, 4' of the two weight subassemblies are perpendicular to each other and the operation is based on the gyroscopic principle. This regime is intended for the type of training in which the main objective is to correct the biomechanics of the movement, the device in question opposing the change in the position of the longitudinal central axis of rotation of the electric motors 4, 4'. The difference with the previous case is that, in addition to maintaining the correct position of the hand from the pronation/supination point of view, this regime allows the correct maintenance of the hand in case of adduction/abduction, as well as in case of circumduction at the shoulder level. Through the opposition achieved by the device in question, in addition to the development of the main musculature, represented by the biceps brachii, a development of the auxiliary musculature will also be obtained, represented by the supinator/pronator of the forearm, the flexors/extensors of the hand, the rotator cuff of the shoulder and the triceps brachii, thanks to their tension to maintain the correct position of the hand and respectively to ensure the controlled extension of the elbow. This ensures joint stability at the level of the elbow, hand, and shoulder;
- The mode of operation in which the central longitudinal axes of the electric motors 4, 4' of the two weight subassemblies are parallel to each other and perpendicular to the central longitudinal axis of symmetry of the handle, and the operation is based on the gyroscopic principle. This regime is intended for the type of training in which the main objective is to correct the biomechanics of the movement, the device in question opposing the change in the position of the longitudinal central axis of rotation of the electric motors 4, 4'. In the case of a training intended for the flexor muscles of the elbow (brachial biceps), the device will allow maintaining the correct trajectory of the movement, opposing possible palmar adduction/abduction movements and rotation at the level of the shoulder joint. Through the opposition achieved by the device in question, in addition to the development of the main musculature, represented by the biceps brachii, a development of the auxiliary musculature, represented by the adductor/abductor palmaris, the triceps brachii and the rotator cuff, will also be obtained, due to their tension to maintain the position of the hand to ensure controlled elbow extension. This ensures joint stability at the elbow, shoulder and partially at the hand level;
- The operation mode in which the central longitudinal

axes of the electric motors 4, 4' of the two weight subassemblies are collinear with each other and collinear with the central longitudinal axis of symmetry of the handle, and the operation is based on the principle of the vibrator made with an eccentric element. This regime is intended for the type of training in which the main objective is to produce an overload of the agonist muscles and the training of the antagonist muscles. This ensures joint stability at the level of the elbow and partially at the level of the hand, through the intermittent action exerted on its flexors/extensors and the shoulder, through the intermittent action exerted on its flexors/extensors;

- The mode of operation in which the central longitudinal axes of the electric motors 4, 4' of the two weight subassemblies are parallel to each other and perpendicular to the central longitudinal axis of symmetry of the handle, and the operation is based on the principle of the vibrator made with an eccentric element. This regime is intended for the type of training in which the main objective is to produce an overload of the agonist muscles and the training of the stabilizing muscles represented by the adductor/abductor muscles of the palm and the rotator cuff. This ensures partial joint stability at the level of the hand, through the intermittent action exerted on its adductors/abductors and the shoulder, through the intermittent action exerted on the adductors/abductors and or its rotators;
- The mode of operation in which the central longitudinal axes of the electric motors of the two weight subassemblies are perpendicular to each other and the operation is based on the principle of the vibrator made with an eccentric element. This regime is intended for the type of training in which the main objective is to produce an overload of the agonist muscles and the training of the antagonist and stabilizer muscles represented by the adductor/abductor muscles of the palm and the rotator cuff. This ensures joint stability at the level of the hand and shoulder, through the intermittent action exerted on the adductors/abductors of the palm and shoulder, through the intermittent action exerted on the adductors/abductors and or its rotators, and partial stability at the elbow level, through the intermittent action on the brachial triceps. Partial stability is ensured at the elbow level as only the biceps and triceps brachii muscles are stimulated, not the brachioradialis muscle;
- Operating mode intended to stimulate neuromuscular control at the level of the hand, is the one in which the two upper handle body 14 and respectively lower handle body 14' are mobile. These conditions are aimed at training the muscles responsible for flexing the fingers. The mode is obtained when the two anti-expansion bodies 12, are removed from the pins 11, belonging to the aforementioned handle bodies. In this situation, when the user performs the proposed

training movements, the two bar bodies, left 13 and right 13', respectively, move (together with the weight subassemblies mounted on them) along the channels (10a, 10b) and (10'a) respectively, 10'b provided in the end bodies 10, 10' (see fig. 11 and fig. 12), remaining elastically assembled by means of the extension spring 16, separating the two upper handle bodies 14 and respectively lower 14'. Practically, the movement of the two upper 14 and respectively lower 14' handle bodies is caused by the displacement of the two bar bodies left 13 and respectively right 13', under the combined action of the movements of the user's upper limb and the rotation of the casings 26 of the electric motors 4, 4' positioned on either side of the handle subassembly. This action requires the flexor muscles of the fingers, the reaction of the user's neuromuscular system consisting in the contraction of this muscle, to ensure the correct manipulation of the device and the stabilization of the hand joints. The current condition can be used in conjunction with any of the previous conditions, bringing added joint stability to the upper limb. Within the handle subassembly, the elastic sleeve 17 has the role of maintaining the contact between the two lower and upper handle bodies 14' and 14 and the left and right bar bodies 13 and 13' which are rigidly mounted on the two end bodies 10, 10'. If it is not desired to use this mode, the two anti-expansion bodies 12 are placed on the pins 11 (see fig.8), which results in the fixing of the two upper and lower handle bodies 14 and 14', respectively, on the left and right bar bodies 13 and 13', thus blocking their movement.

[0028] The current device provides the user with the following functions described below.

[0029] Changing the total weight of the device produces an increase in the muscular strain applied to the upper limb of the user. This change can be achieved as follows:

- by the total or partial removal of the pre-existing weights from the two sets, lower (19, 19', 19'') and respectively upper (18, 18', 18'');
- by total or partial replacement of the pre-existing weights from the two sets, lower (19, 19', 19'') and respectively upper (18, 18', 18'') with similar ones made of other material;
- by the total or partial removal of the pre-existing weights from the two sets of eccentric weights (24, 24', 24'', 24''');
- by the total or partial replacement of the pre-existing weights from the two sets of eccentric weights (24, 24', 24'', 24''') with similar ones made of other material.

[0030] Changing the total weight of the device by replacing or removing (total or partial) the weights is

achieved as follows:

- In the case of the two sets, lower (19, 19', 19'') and respectively upper (18, 18', 18''), they are fixed with friction in a specific recess made in the rubber wall of the two lower weight covers 6, 6' and respectively upper weight covers 8, 8'. Keeping them in the position in which they are located is achieved due to the friction between them and the wall of the housing in which they are located. Their removal is carried out with the help of one of the anti-rotation bodies 9, by inserting one of the extremities 9a or 9b into one of the corresponding bores in the pairs (6e, 6f) and/or (8e, 8f) and pushing the weights outward with the help of this body. Once the weights are extracted, they are replaced with different weights, similar in shape, corresponding to the proposed purpose, inserting the latter in the previously mentioned slots;
- In the case of the two sets of eccentric weights (24, 24', 24'', 24'''), they are friction fitted in the slots (26a, 26b, 26c, 26d) specifically made in the casing 26, of the electric motor 4, 4', these having a rubber layer on the inside necessary to increase adhesion. The removal of these eccentric weights (24, 24', 24'', 24''') is carried out with the help of one of the anti-rotation bodies 9, by pushing the weights outward with the help of this body 9. Once the weights are extracted, they are replaced with different weights similar in shape, corresponding to the intended purpose, inserting the latter in the previously mentioned slots. This operation is carried out with the two lower weight covers 6, 6' and upper weight covers 8, 8', removed from the assembly of the device in question.

[0031] Regardless of which weights we are talking about, the above operations are carried out with the two lower weight covers 6, 6' and the two upper weight covers 8, 8', removed from the assembly of the device in question. The disassembly of these covers is carried out by first removing from each weight subassembly, the locking bodies 7 and the anti-rotation body 9 corresponding to the main connector 22. Once this is done, the two weight covers lower 6, 6' and upper 8, 8' can be detached relatively easily from the device assembly in question. The replacement of these covers on the assembly of the invention is carried out in the reverse direction of their removal.

[0032] Changing the amplitude of the vibration. This change can be achieved as follows:

- by the total or partial removal of the pre-existing weights from the two sets of eccentric weights (24, 24', 24'', 24''');
- by the total or partial replacement of the pre-existing weights from the two sets of eccentric weights (24, 24', 24'', 24''') with similar ones made of other material;

- changing the vibration frequency. This modification can be achieved by wireless control of the electronic control module 5, of the electric motors 4, 4' belonging to each of the two weight subassemblies of the proposed device.
- the casing 26 of each electric motor 4, 4' can rotate with different values of the speed transmitted through the electronic control module 5.

[0033] Regardless of the principle and function chosen, if two such devices are used simultaneously, by different ordering of the parameters of the pairs of electronic control modules 5 of each of them and/or the selection of a different total weight for each device, a differentiated training of the two upper limbs can be achieved. This differentiated training is required if one of the upper limbs is less developed or is in a post-traumatic state that requires medical recovery sessions. The parameters of the two electric motors 4, 4' are controlled from the outside (wireless), by means of a dedicated application, installed on an external device (mobile phone, tablet, computer, or laptop). Depending on the type of muscle strain desired, these electric motors 4, 4' can be ordered to work synchronously or asynchronously and their working parameters (frequency and amplitude) can be set differently for each of them.

[0034] The choice of the operating conditions of the current device must be made considering first the level of physical development of the user, the existence or not of a functional limitation of a traumatic, post-traumatic or anatomical nature and with the gradual increase in the level of neuromuscular strain regarding the total training load and the muscle groups recruited to cope with the resistance imposed by the proposed invention.

[0035] The selection method of the operating regime depends on the way in which the two weight subassemblies are in relation to each other and to the handle subassembly and is carried out as follows:

- The operation mode in which the axes of the electric motors of the two weight subassemblies are collinear - the selection of this mode is achieved by mounting (by screwing) the two weight subassemblies with the secondary arms 1b, of the fork-type bodies 1, 1' on the end bodies 10, 10' of the handle subassembly. To ensure the position of the two weight subassemblies on the handle subassembly, the current device is provided with a locking mechanism based on the insertion of the anti-rotation body 9 through the pair of guide bushings 25 (corresponding to the secondary arms 1b), of the lower weight cover 6, 6', in the slots pairs (10c, 10d) and respectively (10'c, 10'd) provided in the end bodies 10, 10' (see fig.5 and fig.7). In this way, they are electrically connected with the left handle connectors 23 and the right handle connectors 23' of the handle subassembly, with the second connectors 20 of the weight subassemblies and thus the two electric motors 4, 4' and the two

electronic control modules 5 are powered;

- The operation mode in which the axes of the electric motors of the two weight subassemblies are parallel to each other and perpendicular to the axis of symmetry of the handle - the selection of this mode is carried out by mounting (by screwing) the two weight subassemblies with the main arms 1a of the fork-type bodies 1, 1' on the end bodies 10, 10' of the handle subassembly. To ensure the position of the two weight subassemblies on the handle subassembly, the current device is provided with a locking mechanism based on the insertion of the anti-rotation body 9 through the pair of guide bushings 25 (corresponding to the main arms 1a, one bushing belonging to the lower weight cover 6, 6' and the other to the upper weight cover 8, 8'), in the slots pairs (10c, 10d) and respectively (10'c, 10'd) provided in the end bodies 10, 10'. In this way, the left handle connector 23 and respectively the right handle connector 23', of the handle subassembly, are electrically connected with the main connector 22 of the weight subassemblies, and thus the two electric motors 4, 4' and the two electronic control modules 5 are powered;
- The operation mode in which the axes of the electric motors of the two weight subassemblies are perpendicular to each other and perpendicular to the axis of symmetry of the handle - the selection of this mode is carried out, as in the previous case, by mounting (by screwing) the two weight subassemblies on the main arms 1a, of the fork-type bodies 1, 1', on the end bodies 10, 10' of the handle subassembly. The difference from the previous situation is that one of the anti-rotation bodies 9 is inserted through the pair of guide bushings 25 (corresponding to the main arm 1a, one bushing belonging to the lower weight cover 6, 6' and the other to the upper weight cover 8, 8'), in the slots pair (10c, 10d) provided in the end body 10, and the second anti-rotation body 9 is inserted through the pair of guide bushings 25 (corresponding to the main arm 1a, one bushing belonging to the lower weight cover 6, 6', and the other to the upper weight cover 8, 8') in the slots pair (10'e, 10'f) provided on the end body 10' (see fig. 10). In this way, the left handle connector 23 and respectively the right handle connector 23', of the handle subassembly, are electrically connected with the main connectors 22 of the weight subassemblies and thus the two electric motors 4, 4' and the two electronic control modules 5 are powered;
- The operation mode based on the gyroscopic principle is selected when both sets of eccentric weights (24, 24', 24'', 24''') are fitted inside the slots (26a, 26b, 26c, 26d) specifically made in the casing 26 of the electric motor 4, 4' or when both sets of eccentric weights (24, 24', 24'', 24''') are removed from the slots (26a, 26b, 26c, 26d) specifically made in the casing 26 of the electric motor 4, 4';
- The operation mode based on the vibrator principle

with an eccentric element is selected when one or more (not all) of the weights of the eccentric weight sets (24, 24', 24'', 24''') are removed from the slots corresponding on the casing 26 of the electric motor 4, 4'.

[0036] Thus, according to a preferred embodiment of the invention, each weight subassembly is provided with four weights (24, 24', 24'', 24''') fitted inside the casing (26) on a concentric circle with the central longitudinal axis of each electric motor (4, 4') and angular equidistant or no weight subassembly is provided with such weights (24, 24', 24'', 24''').

[0037] Another preferred embodiment of the invention has a first weight subassembly additionally provided with a maximum of three weights (24, 24', 24'', 24''') fixed eccentrically in relation to the central longitudinal axis of the first electric motor (4), inside the casing (26) so that during the operation of the electric motors (4, 4'), a vibratory movement perceptible by the user is additionally generated.

[0038] In another preferred embodiment of the invention, both weight subassemblies are provided with a maximum of three weights (24, 24', 24'', 24''') fixed eccentrically in relation to the central longitudinal axis of the two electric motors (4, 4'), inside the casing (26) such that during the operation of the electric motors (4, 4'), each position of the central longitudinal axis of each electric motor (4, 4') changes compared to a non-operative position of the device, generating a vibratory movement, this being perceptible by the user in the form of a complex neuromuscular strain in two anatomical planes.

[0039] In another preferred embodiment of the invention, a first weight subassembly is provided with a maximum of three weights (24, 24', 24'', 24''') fixed eccentrically in relation to the central longitudinal axis of the first electric motor (4), inside the casing (26) and the second weight subassembly is provided with four weights (24, 24', 24'', 24''') arranged inside the casing (26) on a concentric circle with the central longitudinal axis of the second electric motor (4') and angular equidistant such that during the operation of the electric motors (4, 4'), each position of the central longitudinal axis of each electric motor (4, 4') changes with respect to a non-operative position of the device, depending on a direction in which a user translates or rotates the portable dumbbell-type device, generating a precession force and a vibratory movement, these being perceptible by the user in the form of a complex neuromuscular strain in two anatomical planes.

[0040] In the sense of the above mentioned, it should be specified that the slots pairs (10c, 10d) and respectively (10'e, 10'd) are perpendicular to the slots pairs (10e, 10f) and respectively (10'e, 10'f) (see fig.7). Likewise, the axes of the slots pairs (10c, 10d) and respectively (10'e, 10'd) are not coplanar with the axes of the slots pairs (10e, 10f) and respectively (10'e, 10'f). The existing gap allows the mounting of the two motors 4, 4'

with their axes perpendicular to each other and is due to the fact that this positioning of the motors is achieved by screwing.

[0041] The transition from one operation mode to another is carried out as follows:

- The anti-rotation bodies 9 are removed from the end body 10 and/or the end body 10', thus allowing the total or partial unscrewing of the desired weight subassembly from the handle subassembly;
- Replace/reposition the unscrewed weight subassembly on the handle subassembly, in the position suitable for the desired operation mode;
- Re-insert the anti-rotation bodies 9 on the end body 10 and/or on the end body 10', from which it was removed.

[0042] The start and/or stop of the action of the motors 4, 4' can be done as follows:

- by initiating a movement of the upper limb (of the user) that manipulates the device in question, this being sensed and interpreted by the electronic control modules 5 as a signal to start the two motors. In this situation, the motors will stop if the electronic control modules 5 do not detect any movement for a few seconds, ordering the two motors to stop;
- through external, specific sound commands, vocally generated by the user, received and interpreted, by electronic control modules 5 as a signal to start or stop the two motors;
- by wireless commands generated from an external device with which the proposed invention is connected. Both the start and stop commands can be timed, thus obtaining a structured training plan, containing the duration of each continuous training session, the duration of each break and the total duration of the training, when it is composed of several chained sessions.

[0043] In the sense of the aforementioned, it should be noted that the electronic control modules 5 are provided with sensors and/or electronic elements necessary for sensing and/or receiving external control signals, regardless of their nature. Also, the invention allows wireless connection with external devices (mobile phone, tablet, computer or laptop), by means of a dedicated software application. There are two wireless communication modules which are each integrated in one of the electronic control modules 5. Due to this fact, as previously mentioned, the dedicated software application will allow the setting of the operating parameters of the electric motors 4, 4' both individually (for each of the two motors of the proposed invention) as well as in pairs when two such proposed devices are used simultaneously. The software application will also allow to set the duration of each training session, the total number of chained sessions and the duration of each session break. In this situation,

starting and/or stopping the electric motors 4, 4' of the device in question can be done exclusively through the software application. It will also be able to generate an evolution graphic regarding the development of biometric parameters and the correctness of the biomechanics of the movements, based on the information provided by the set of motion sensors comprised in the electronic control modules 5.

[0044] Considering the portable device for developing the level of neuromuscular control and the motor parameters of the musculature of the upper limbs ready for work, the user grasps the handle subassembly thereof by hand, generating the starting signal of the motors of the current invention. Thus, the desired training will begin by performing the specific movements. The user can change the operating parameters of the electric motors 4, 4', the desired operating regime, as well as the total weight of the device at any time. The latter refers to the weight of the device when its motors are off.

[0045] The development of biometric parameters (speed, strength and endurance) and the level of neuromuscular control is achieved over time as a consequence of the use of the proposed invention and is dependent on the type of training chosen, i.e. on the management mode of the combination of the operating regime for which the total set weight was also opted for. The more the chosen operation mode of the proposed device, requires the recruitment by the user's neuromuscular system of a greater number of main and auxiliary musculature's groups, the more the increase in the level of neuromuscular control at the level of his upper limbs will be more pronounced. Increasing the level of neuromuscular control of the user's upper limbs will allow correct movements from a biomechanical point of view, ensuring stability and therefore joint integrity, while optimizing effort and energy consumption. The greater the load (total weight) of the current device, the greater the increase in muscle strength will be, over time. By increasing the frequency of movements using the proposed invention, an increase in muscle speed is obtained over time, and by increasing the duration of time allocated to each training session, an increase in the level of muscular endurance of the user's upper limbs will be obtained over time.

Claims

1. Portable dumbbell-type device for developing the level of neuromuscular control and the motric parameters of the upper limbs musculature of a user, comprising:

- two weight subassemblies, mounted at a first end and respectively at a second end of a handle subassembly,
- each weight subassembly being configured in the form of an enclosure, which

includes therein:

- a fork-type body (1, 1') comprising a main arm (1a) having an "U" shape and a secondary arm (1b) perpendicular to the main arm (1a), wherein the fork-type body (1, 1') is connected to one of said handle subassembly's ends by means of one of the main (1a) or secondary (1b) arms;
- a brushless direct current electric motor (4, 4') comprising a rotor configured in the form of a casing (26) and which can rotate around its own central longitudinal axis and around a rigidly mounted stator (27), by means of a shaft (2, 2'), on the fork-type body (1, 1');
- an electronic control module (5) fixed to the stator (27);

- the handle subassembly being configured in the form of a longitudinal, substantially cylindrical profile, comprising therein two electric batteries (15, 15') which respectively supply an associated electric motor (4, 4'), each electric battery (15, 15') being located at one end of the handle subassembly,

characterized in that

the central longitudinal axes of the two electric motors (4, 4') are positioned:

- perpendicular to a central longitudinal axis of the handle subassembly or
- a central longitudinal axis of the first electric motor (4) is collinear with the central longitudinal axis of the handle subassembly and a central longitudinal axis of the second electric motor (4') is perpendicular to the central longitudinal axis of the handle subassembly and

the rotation of each rotor of the two electric motors (4, 4') takes place in different planes
such that

during the operation of the electric motors (4, 4'), each position of the central longitudinal axis of each electric motor (4, 4') changes with respect to a non-operative position of the device, according to a direction in which a user translates or rotates the portable dumbbell-type device, generating a precession force generated by the rotation of each rotor, this force being perceptible by the user as a complex neuromuscular strain in at least two anatomical planes.

2. Portable dumbbell-type device according to claim 1, **characterized in that** each weight subassembly is provided with four weights (24, 24', 24", 24''') arranged inside the casing (26) on a concentric circle with the central longitudinal axis of each electric motor (4, 4') and angular equidistant. 5
 3. Portable dumbbell-type device according to claim 1, **characterized in that** a first weight subassembly is additionally provided with a maximum of three weights (24, 24', 24", 24''') fixed eccentrically with respect to said central longitudinal axis of the first electric motor (4), inside the casing (26) **such that** during the operation of the electric motors (4, 4'), an additional vibrational movement perceptible by the user is generated. 10 15
 4. Portable dumbbell-type device according to claim 3, **characterized in that** the second weight subassembly is additionally provided with a maximum of three weights (24, 24', 24", 24''') fixed eccentrically with respect to said central longitudinal axis of the second electric motor (4'), inside the casing (26) **such that** during the operation of the electric motors (4, 4'), each position of the central longitudinal axis of each electric motor (4, 4') changes with respect to a non-operative position of the device, generating a vibratory movement, this being perceptible by the user as a complex neuromuscular strain in two anatomical planes. 20 25 30
 5. Portable dumbbell-type device according to claim 3, **characterized in that** the second weight subassembly is additionally provided with four weights (24, 24', 24", 24''') arranged inside the casing (26) on a concentric circle with the central longitudinal axis of the second electric motor (4') and angular equidistant **such that** during the operation of the electric motors (4, 4'), each position of the central longitudinal axis of each electric motor (4, 4') changes with respect to a non-operative position of the device, depending on a direction in which a user translates or rotates the portable dumbbell-type device, generating a precession force and a vibratory movement, these being perceptible by the user as a complex neuromuscular strain in two anatomical planes. 35 40 45
 6. Portable dumbbell-type device according to any of claims 1-5 **characterized in that** the handle subassembly additionally comprises: 50
 - a left bar body (13) and a right bar body (13') located inside the handle subassembly, each having a first extremity rigidly fixed to an associated end body (10, 10'), each located on one end of the handle subassembly and each connected to an associated weight subassembly, 55
 - an extension spring (16) located inside the handle subassembly and connecting a second extremity of the left bar body (13) with a second extremity of the right bar body (13'),
 - an upper handle body (14) and a lower handle body (14') arranged such that between them are placed said bar bodies (13, 13') and the extension spring (16),
 - an elastic sleeve (17) that surrounds the upper handle body (14) and the lower handle body (14') and keeps them permanently in contact, in the non-operative state, on the two bar bodies (13, 13'),
- such that** during the operation of the portable dumbbell-type device, said upper and lower handle bodies (14, 14') can move independently of each other due to the displacement of the bar bodies (13, 13') under the combined action of the movements performed by user and of the rotation of each rotor.
7. Portable dumbbell-type device according to any of claims 1-6, **characterized in that** each weight subassembly further comprises an upper set of weights (18, 18', 18") and/or a lower set of weights (19, 19', 19"), preferably mounted on a lower weight cover (8, 8') and/or respectively on an upper weight cover (6, 6').
 8. Portable dumbbell-type device according to any of claims 1-7, **characterized in that** the electronic control module (5) is configured **such that** it can be controlled wirelessly by a user.
 9. Portable dumbbell-type device according to any of claims 1-8, **characterized in that** the casing (26) of each electric motor (4, 4') can rotate with different rotational speed values controlled by the electronic control module (5).
 10. Portable dumbbell-type device according to any of claims 1-9, **characterized in that** the casing (26) of each electric motor (4, 4') is provided with a maximum of four slots (26a, 26b, 26c, 26d) having a circular cross-section, placed on a circle concentric with the central longitudinal axis of each electric motor (4, 4') and angular equidistant, inside which at least one weight (24, 24', 24", 24''') can be placed.

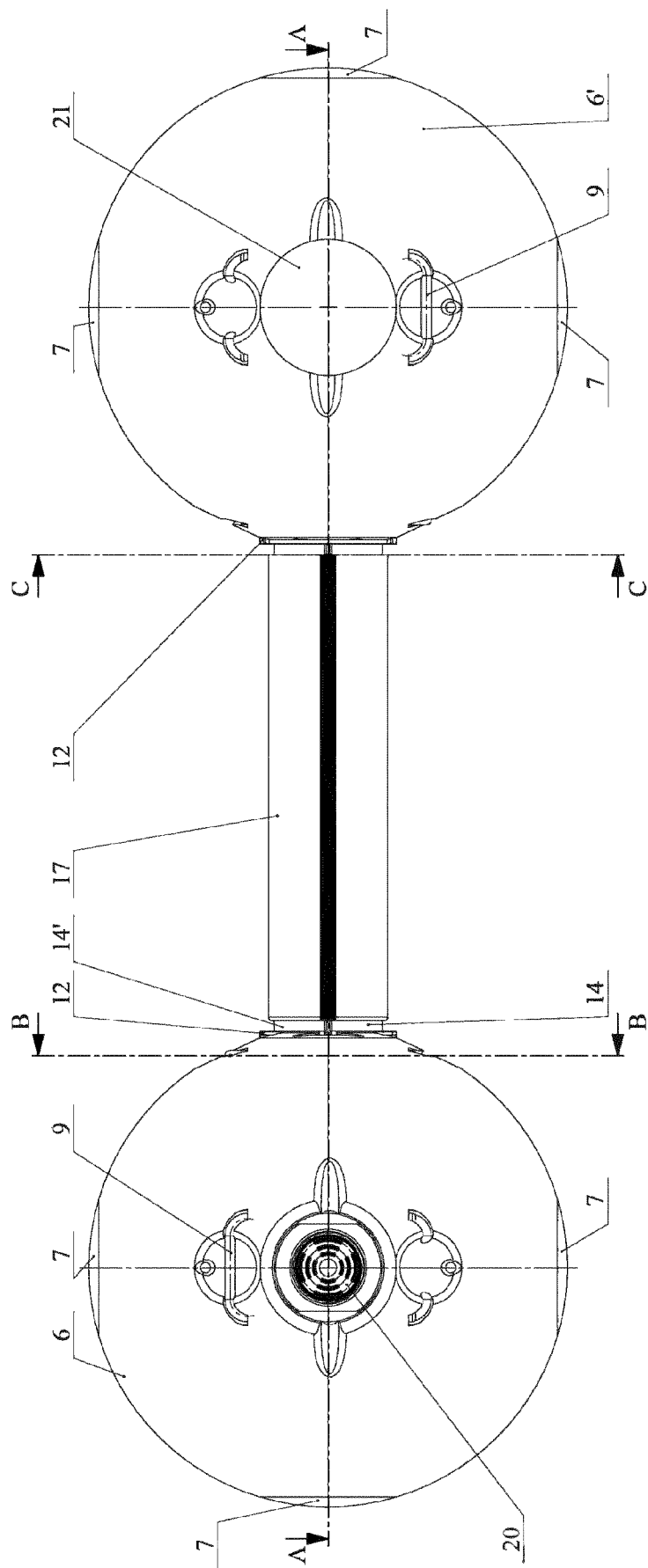


fig.1

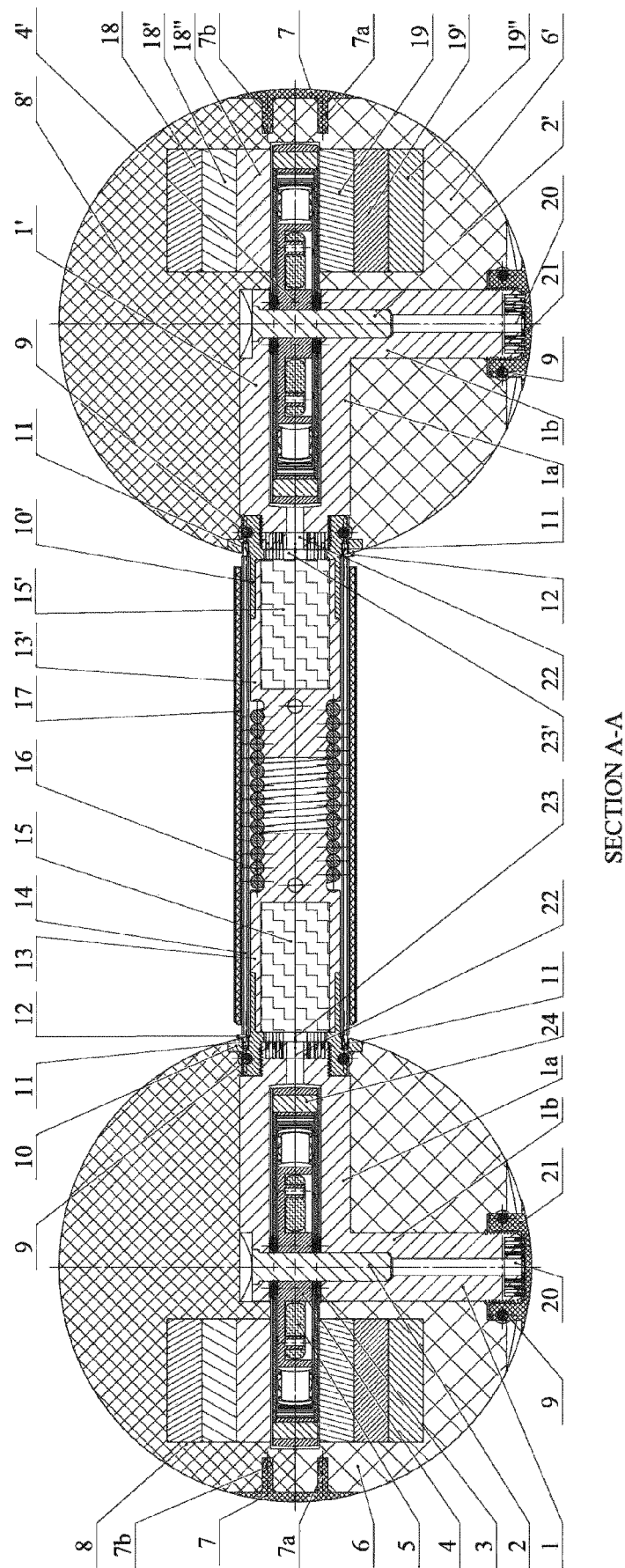


fig.2

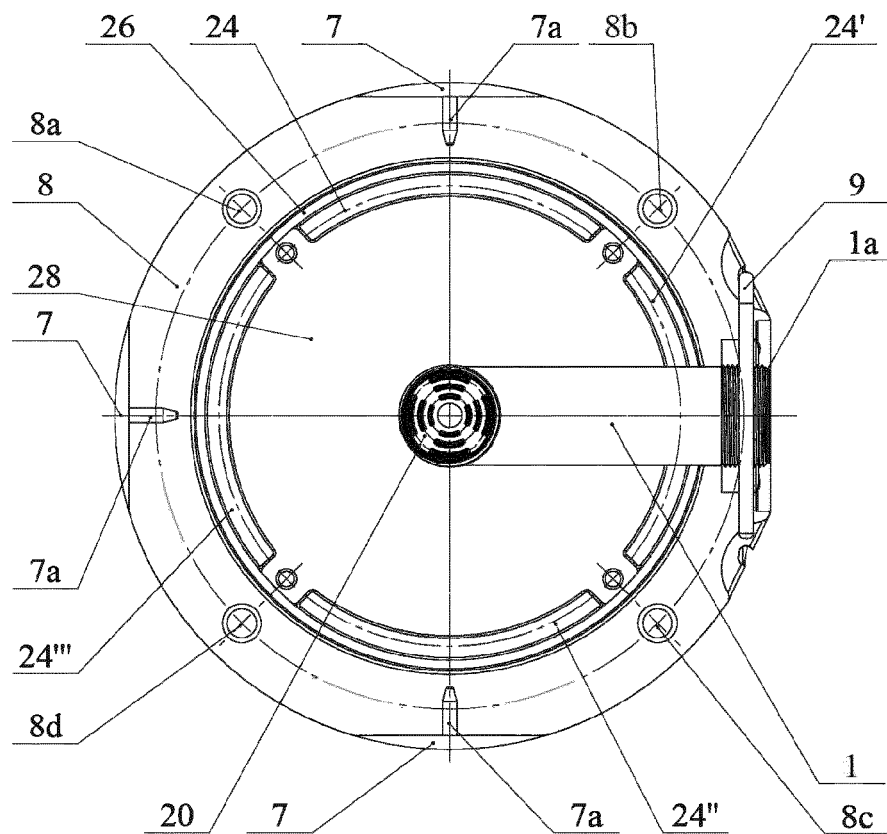


fig.3

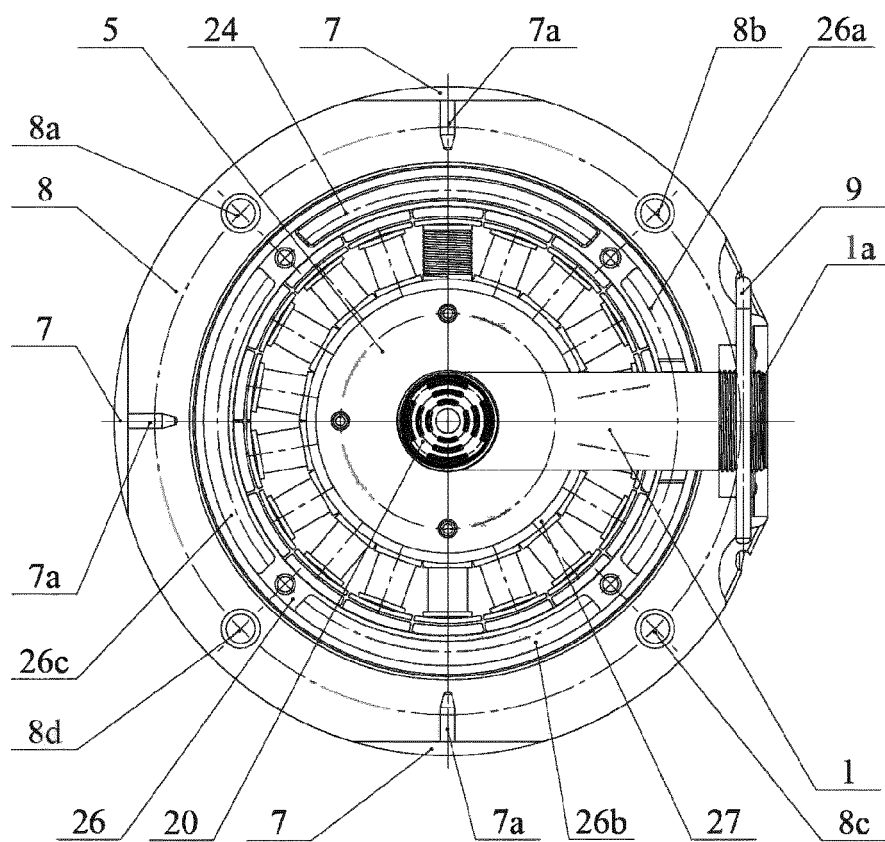
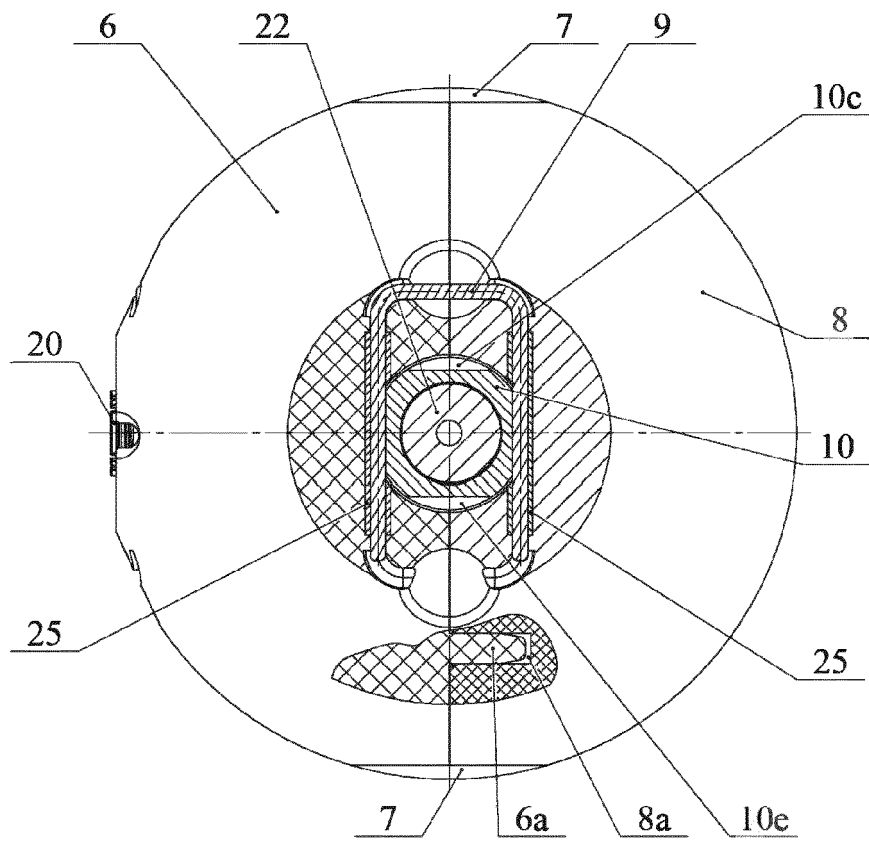
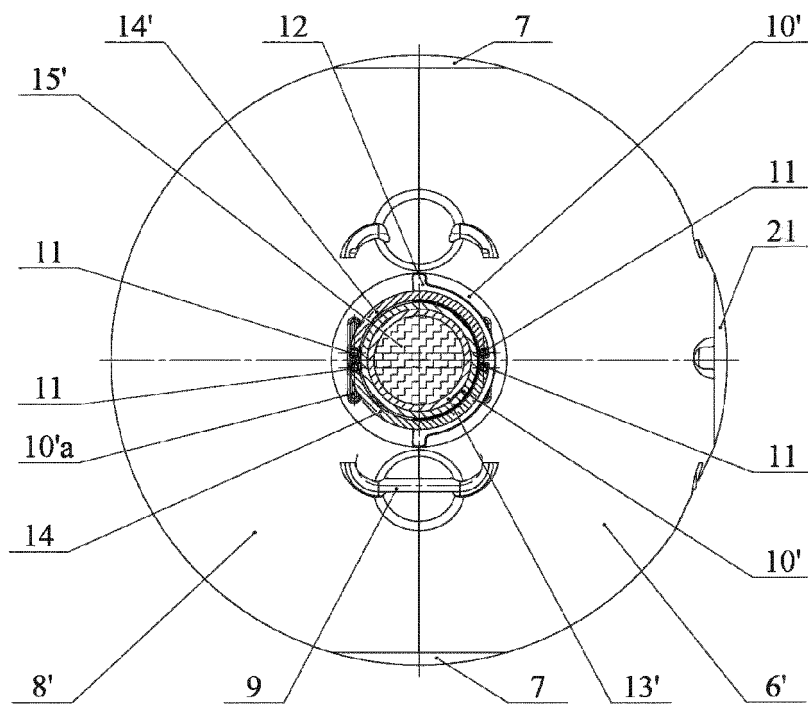


fig.4



SECTION B-B

fig.5



SECTION C-C

fig.6

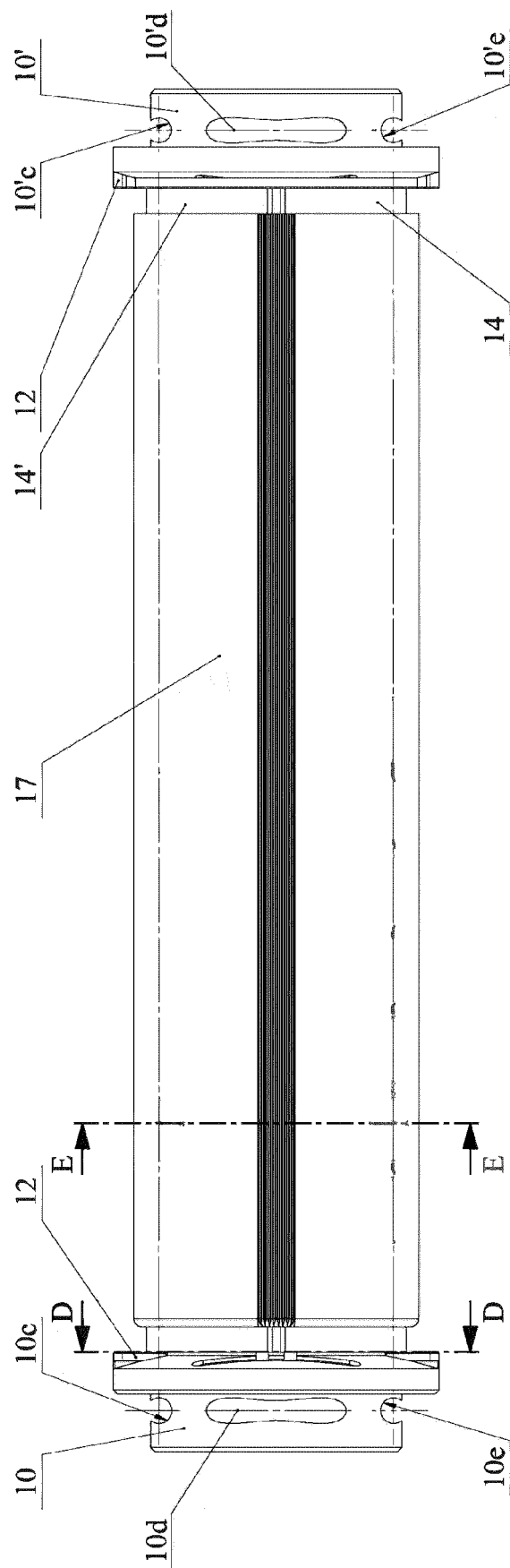
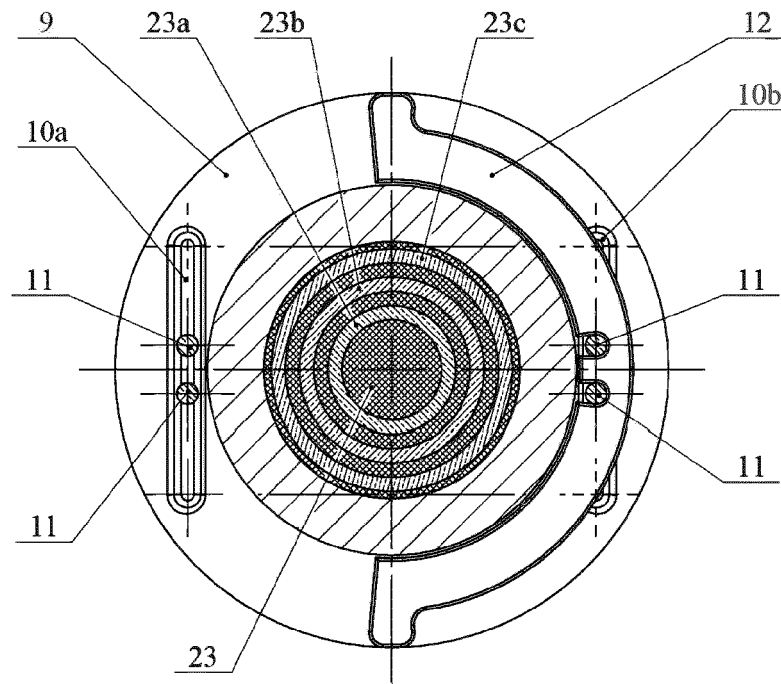
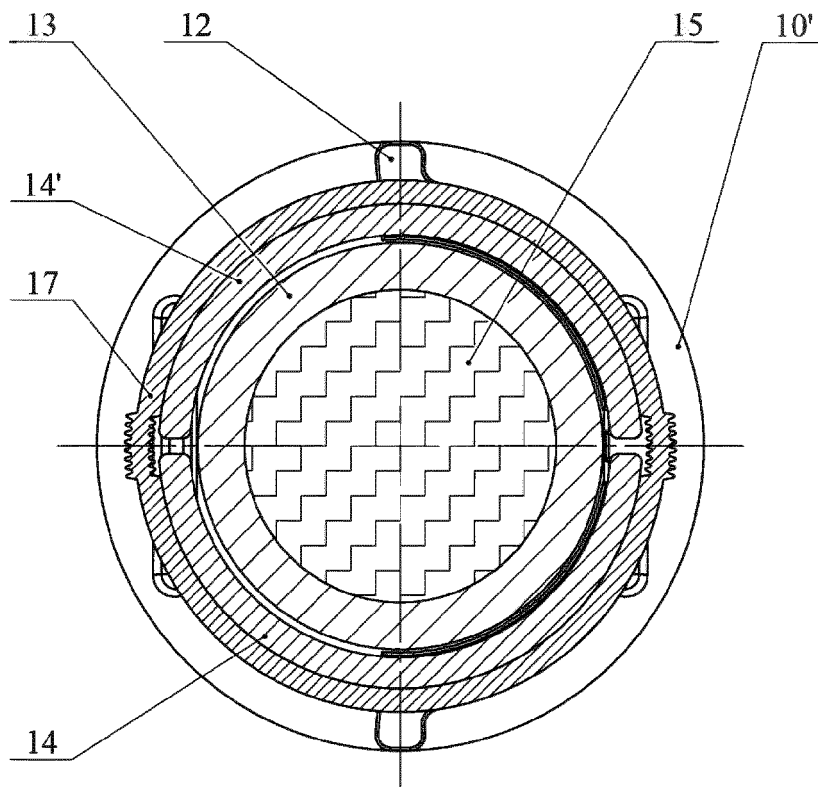


fig.7



SECTION D-D

fig.8



SECTION E-E

fig.9

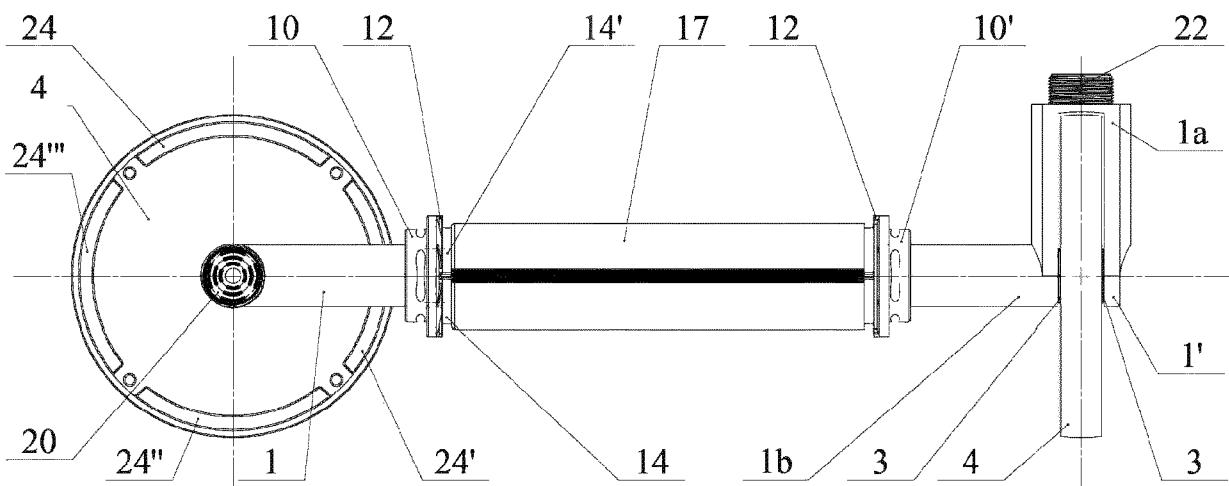


fig.10

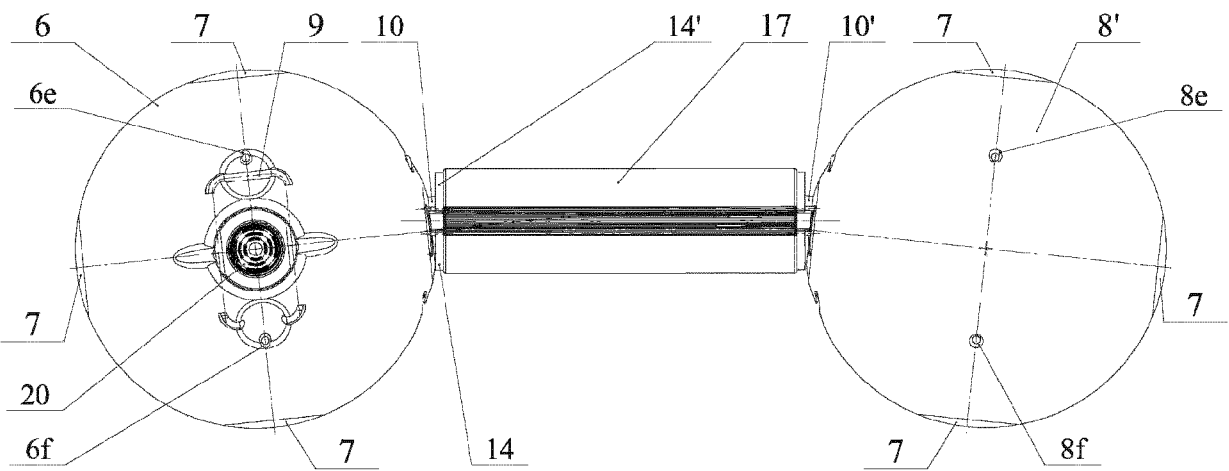


fig.11

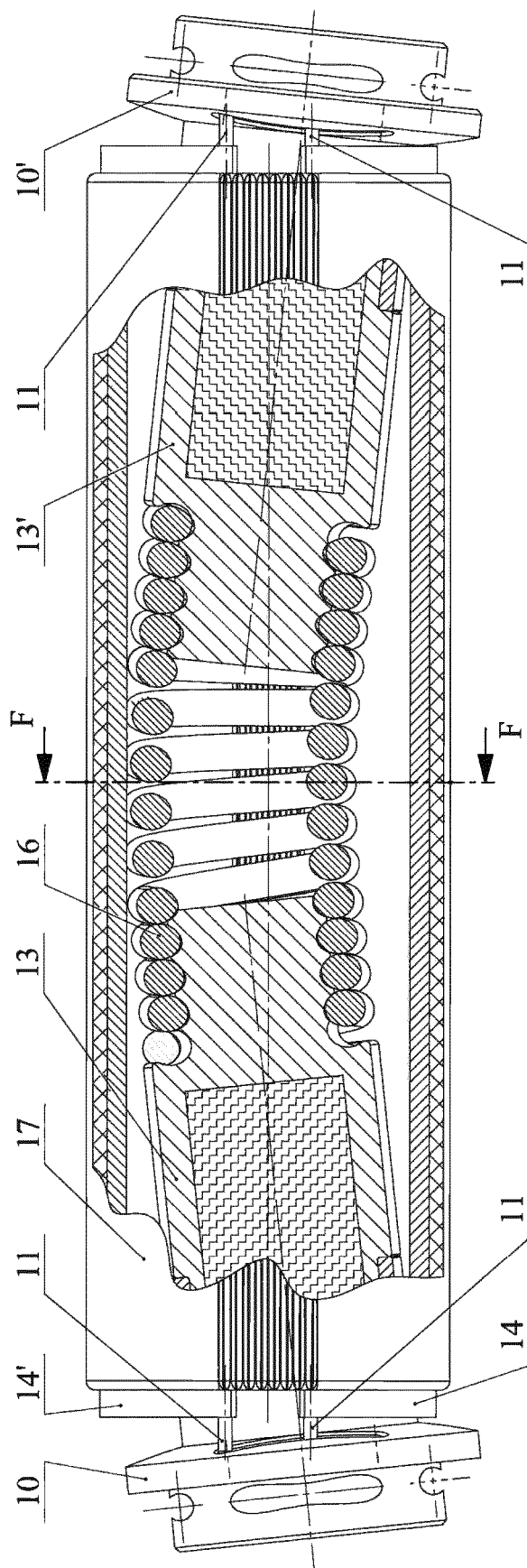
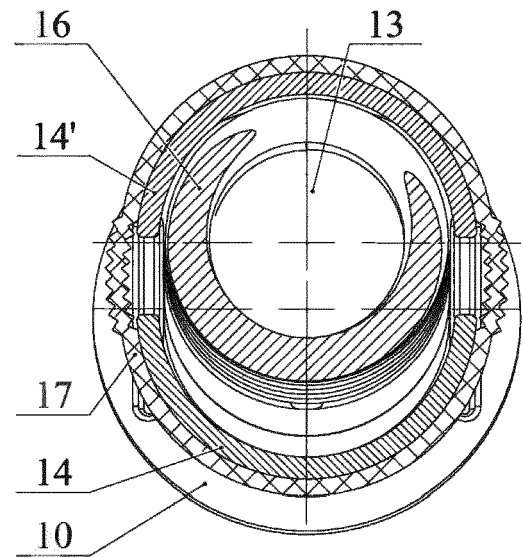


fig.12



SECTION F-F

fig.13

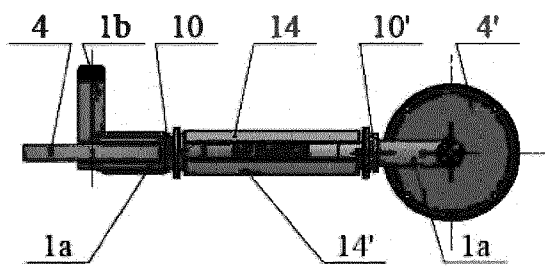


Fig. 14.a1

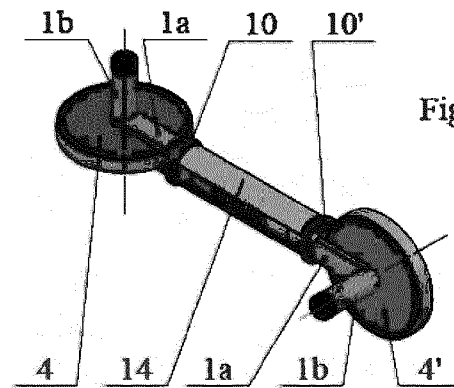


Fig. 14.a2

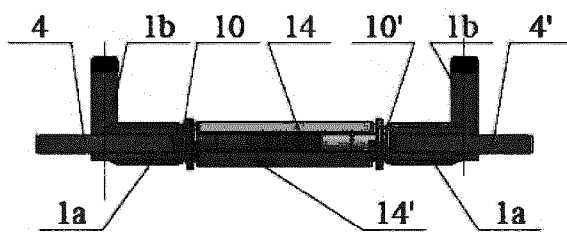


Fig. 14.b1

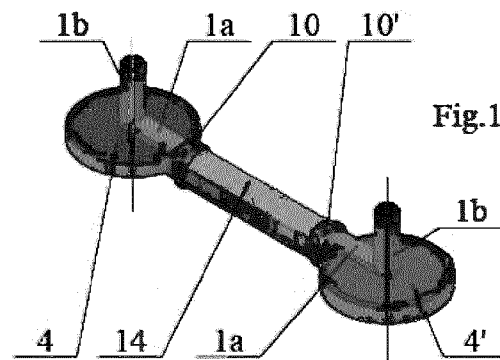


Fig. 14.b2

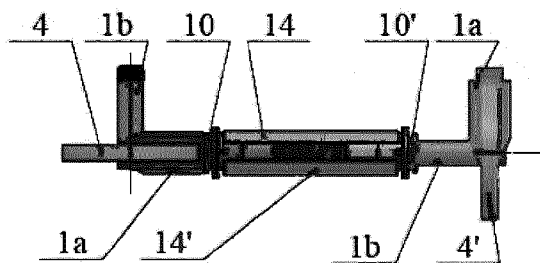


Fig. 14.c1

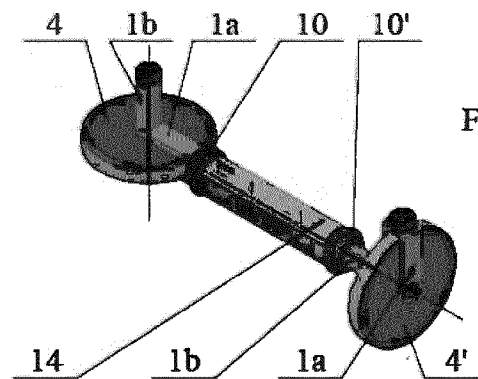


Fig. 14.c2

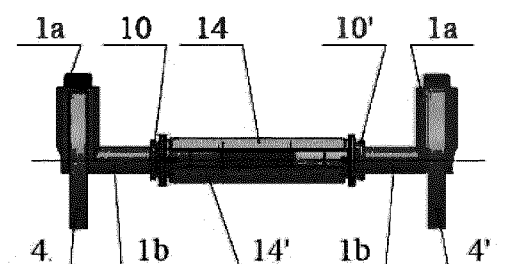


Fig. 14.d1

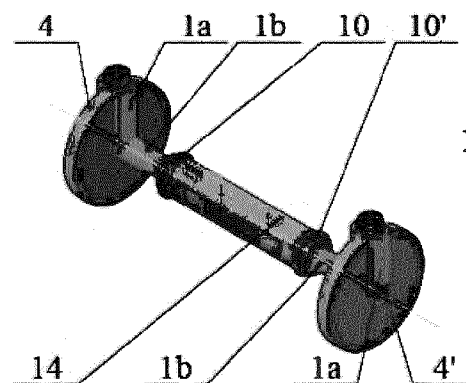


Fig. 14.d2



EUROPEAN SEARCH REPORT

Application Number

EP 24 46 5515

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2012/115690 A1 (CHEN PAUL [CA]) 10 May 2012 (2012-05-10) * paragraph [0029] - paragraph [0035]; figures 2-6 *	1-10	INV. A63B21 A63B24
A	GB 2 485 908 A (GRIFFITHS JAMES [GB]) 30 May 2012 (2012-05-30) * page 8, line 1 - page 10, line 25; figures 1-21 *	1-10	
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A	DE 195 32 254 C1 (KLASEN HEINZ PROF DIPL ING [DE]) 24 October 1996 (1996-10-24) * the whole document *	1-10	
A	US 8 118 717 B1 (LAI SHU-CHIUNG LIAO [TW]) 21 February 2012 (2012-02-21) * the whole document *	1-10	TECHNICAL FIELDS SEARCHED (IPC) A63B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 1 October 2024	Examiner Brumme, Ion
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