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(54) Device for active movement of a person or object

(57) The present application relates to a device (1) for active movement of a person or object comprising a base structure (2) and a platform (3) movably supported on the base structure (2) by means of a support (4). The support (4) is arranged between said base structure (2) and said platform (3) and is configured to allow a movement of said platform (3) in at least three degrees of freedom. At least three cables (6.1, 6.2, 6.3) are fastened to an underside of said platform (3) at a first end. The at least three cables (6.1, 6.2, 6.3) are fastened at a second end to a common initial point (8), said initial point (8) being freely movable at least in one plane by actuation means.

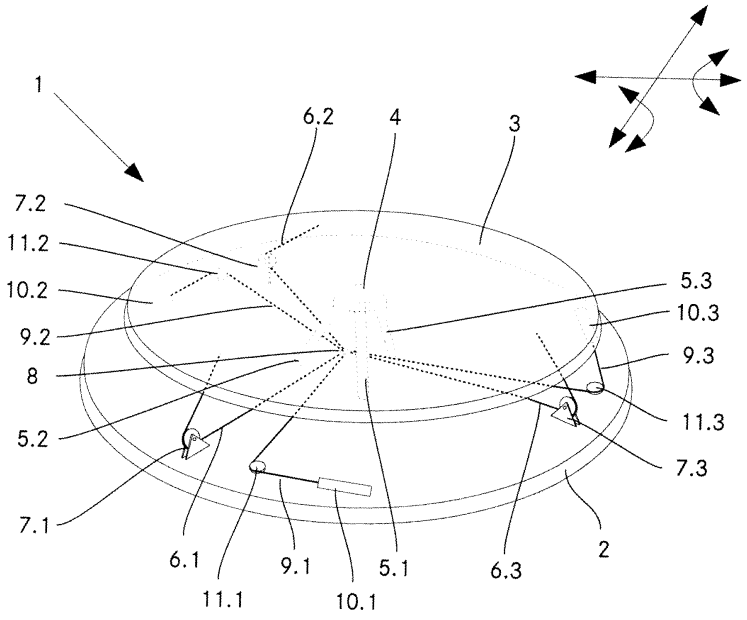

Fig. 1

EP 2 851 106 A1

Description

Technical field

[0001] The present invention relates to a device for active movement of a person or object.

Prior art

[0002] Different devices for movement of a person or object are known, e.g. in the field of exercise and rehabilitation equipment.

[0003] WO 2007/035976 A2 (Ferrara Paolo) describes a device for moving people or objects in a flexible controllable manner, e.g. for purposes of play, sport, pedagogy or therapy. Pneumatic actuators without a piston are arranged between a fixed part and a movable part. As the actuators may only exert force in one direction, a combination of actuator and spring element or a combination of two actuators acting in opposite directions are provided. The movable part may be rotated in two degrees of freedom as well as translated linearly in a vertical direction by providing three actuator combinations connected at three locations distanced from each other of the movable part. The actuator combinations may be connected to the movable part by means of cables being deflected by means of a deflection roller. The movement of the actuators may be controlled by means of a specific algorithm allowing a desired movement of the movable part of the device.

[0004] This device has the disadvantage that two actuation elements are needed for any force imparted on the movable part, one acting in one direction and the other acting in the reverse direction. Hence, a high number of actuators have to be used even for a device only allowing simple movements. This increases the cost and the complexity of an appropriate control means.

[0005] EP 2 228 101 A1 (Moritz Martin) describes a training device with a base plate, a ball caster arranged on said base plate and a board movably arranged on the ball caster. The movable board is further connected with the base plate by means of a plurality of elastic strips.

[0006] Such an arrangement has the disadvantage that only passive movement of the board is possible. No active motion may be imparted to the board.

[0007] WO 03/103858 describes a device with a fix frame and two table-like plates arranged parallel to each other. Both plates may be moved independent of each other in three spatial directions. A motorized drive puts the plates into a randomized, oscillating motions which follow an elliptical or circular trajectory. These motions are caused by an eccentric roll acting on the plates and being connected to the motor.

[0008] While such an arrangement is capable of generating a stochastic motion it is not possible to control the direction or extent of this motion.

Description of the invention

[0009] It is an object of the present invention to provide a device capable of reliably imparting active movement to a person or object in different spatial directions and which is simple in construction.

[0010] The underlying technical problem is solved by a device for active movement of a person or object comprising a base structure and a platform movably supported on the base structure by means of a support. The support is arranged between said base structure and said platform and is configured to allow a movement of said platform in at least three degrees of freedom. At least three cables are fastened to an underside of said platform at a first end. The at least three cables are fastened at a second end to a common initial point, said initial point being freely movable at least in one plane by actuation means.

[0011] By providing a movable initial point connected to the movable platform a very simple and reliable actuation of the platform is realized. By simply moving the initial point in a plane, i.e. with two degrees of freedom it is possible to impart a movement in at least three degrees of freedom to the platform. Such a device has a wide range of applications, but is preferably used as therapeutic or training device for persons.

[0012] The base structure serves as scaffold for the elements of the device. Preferably, the base structure comprises a plate or feet onto which the device may be placed on the ground. Further, the base structure also comprises any bearings for the platform as well as attachment points for the actuation means. The base structure may be of any suitable kind, e.g. in the form of a box, strut arrangement, etc. Preferably, the base structure is made of any suitable material having a sufficient strength and rigidity to support the elements of the device as well as a person standing on the platform or any object placed thereon. Preferably, the base structure therefore comprises steel, aluminium, hardwood, fibre glass or any other suitable material. Preferably, the base structure comprises a mixture of different materials, e.g. steel bars enclosed by a polymer housing.

[0013] The platform preferably is in the shape of a substantially flat board onto which a person may stand on or onto which an object may be placed. The platform may more preferably include at least one structural element which provides a good grip of a person standing on the platform, e.g. an at least partially corrugated surface, depressions for placing feet therein, etc. Further, the platform may comprise a restraint element allowing to affix feet of a person or an object to the platform to avoid the person or object to fall from the platform during movement thereof. The platform may be made of any suitable material having a sufficient strength to support a person or object placed thereon. Suitable materials may be steel, aluminium, hardwood, fibre glass, polymers etc.

[0014] Specifically, the "degrees of freedom" the platform may be freely moved in comprise linear translation

in a plane parallel to the platform in two spatial directions as well as tilting about two axes parallel to the platform in two directions each.

[0015] The support may be in the form of at least one bearing allowing the movement of the platform relative to the base plate. The at least one bearing may for example be a rolling-element bearing, a plain bearing, a flexible bearing or the like. A combination of different bearings may also be used.

[0016] It is hereby understood that the at least three cables have to be attached to the movable platform at three different attachment points being spaced from each other by an adequate distance and preferably located near an edge of the platform such that the platform may be moved by a small dislodgment of any of the cables.

[0017] The at least three cables are attached to the underside of the platform at an equal distance from each other and the attachment points of the cables to the platform are preferably evenly distributed, e.g. along the circumference of the platform.

[0018] More preferably, three cables are used. The three cables are preferably attached to the underside of the platform at three attachment points which are arranged on the corners of an imaginary equilateral triangle on the platform, i.e. all spaced from each other by an equal distance.

[0019] Although the term "cable" is used throughout the present specification, a person having skill in the art will recognize that ropes, cords, bands or even rigid members such as bars, poles, rods or the like may be used to connect the platform with the initial point, as the function of the cables is to transmit a motion from the initial point to the platform which may equally be performed by any of the alternative elements cited above.

[0020] By moving the initial point in one plane, the at least three cables will be either pulled or pushed by the initial point. Accordingly, any pulling force will be transmitted from a cable to the platform. By using a rigid member it is possible to also transmit a pushing force to the platform. However, in practice, it has been shown that it is sufficient to use a flexible element such as a cable. When the cables are attached at selected attachment points on the underside of the platform, preferably in a regular or symmetrical manner, any motion of the platform imparted by pulling one of the at least three cables may be reversed by pulling at least one of the at least two other cables. This pulling may be simply enabled by reversing the motion of the initial point.

[0021] The initial point itself may be moved in the plane by any suitable means. For example, the initial point may be moved by means of at least two linear actuators, such as pneumatic pistons, acting on the initial point. It is to be noted that the plane within which the initial point is being moved does not need to be parallel the base structure or the platform. Preferably however, this plane is arranged such as to be parallel to the ground the device will be place on.

[0022] The actuation means preferably comprise at least two drive cables which are connected to the initial point at a first end and to an actuator at a second end.

[0023] Providing drive cables allows placing the actuators outside of the range of motion of the initial point, such that there is no movement constraint on the initial point caused by the actuators. The actuators may be passive actuators, such as spring or elastic elements, or may be active actuators, such as motors. Again, a person having skill in the art will recognize that not only cables may be used to connect the actuators with the initial point, but that also ropes, cords, bands or even rigid members such as bars, poles, rods or the like may be used.

[0024] In the case where rigid members are used, it is sufficient to provide only two such members such as to be able to move the initial point in the plane in at least two spatial directions, as rigid members are able to transmit pulling as well as pushing forces alike. In this case, preferably, the two rigid members are attached to the initial point in a way to enclose an angle of 90° to each other.

[0025] Preferably, the actuators are linear actuators. Linear actuators are known to a person having skill in the art and comprise, amongst others, hydraulic and pneumatic pistons. However, more preferably, the actuators are of the pneumatic muscle type.

[0026] Pneumatic muscles, also sometimes referred to as "pneumatic artificial muscles" or "PAM" are contractile or extensional devices operated by pressurized air. Such contractile actuators are e.g. manufactured and sold by Festo AG under the name "fluidic muscle". Such actuators are capable of exerting a contractile force of up to 6'000 N and may contract up to a distance of approximately 25 % of their nominal length. Different nominal lengths are available which reach be up to 9 meters.

[0027] As such pneumatic muscles have a high initial force in any contracting movement and hence allow a high dynamic even when moving relatively heavy loads, very precise motion may be imparted to the initial point and hence to the platform by using such pneumatic muscles. Further, pneumatic muscles also allow a slip-free movement, which is especially important in the case that the device is used as therapeutic or training device for persons.

[0028] It is understood that the use of any pneumatic system includes the arrangement of a corresponding system of valves, tubing and reservoir of pressurized air or a connection valve to such a reservoir on the device.

[0029] Preferably, the device comprises three drive cables which are connected to the initial point, said cables being arranged such as to lead away of the initial point at angles of approximately 120° one to each other.

[0030] It is understood that each of the drive cables is further attached to an actuation means and that hence the device comprises three actuation means. This configuration has the advantage that the initial point may be freely moved about the plane with two degrees of freedom, namely linear translation in two spatial directions, while using a minimal number of drive cables. In fact, the

initial point may be reversibly moved to any distinct point within the plane by using only the three actuation means.

[0031] The initial point is preferably arranged between said base structure and said platform. Such an arrangement allows a compact configuration of the device. Further, the initial point is thus less accessible from the outside which minimizes the risk of an injury to a person caused by the moving initial point and/or the cables.

[0032] Preferably, said support is configured to allow a movement of said platform in four degrees of freedom, preferably by allowing free translation and tilting of said platform about said support.

[0033] Having high degrees of freedom allows using the device in a broad range of applications for therapy or training of persons. Especially in connection with active actuators, specific and controlled movements of the platform in any desired direction or combination of directions is possible.

[0034] To allow a high number of degrees of freedom, the support may e.g. include a plurality of bearings acting together.

[0035] Preferably, however, the support of the platform is a ball caster. A ball caster has the advantage to allow movement of the platform with high number of degrees of freedom while being able to support heavy loads. Further, a ball caster exhibits a relatively low friction so that the force transmitted from the actuators to the platform is maximized.

[0036] The device preferably further comprises a controller for controlling said actuation means. This allows to impart defined motions to a person or object placed on the platform.

[0037] The controller may be of any suitable type to control the actuation means. Preferably, the controller is an electronic controller allowing to individually control each of the actuation means.

[0038] Preferably, the controller is configured such as to move said platform to any combination of translation, rotation and/or tilting about the ball caster through a translation of said initial point by means of the actuation means.

[0039] This allows to individually select specific motions of the platform according to the use of the device, e.g. for therapy or training of a person. Preferably, the controller comprises at least one microprocessor and at least one memory module such that sequences of specific motions may be programmed and stored by the controller. Thereby, the controller is preferably configured such that a specific combination of lateral translation and/or tilting may be inputted by an operator and the correct control signals are automatically sent to the actuation means. Hence, the controller most preferably comprises a suitable algorithm to translate any input of lateral translation, rotation and/or tilting into corresponding control signals sent to the actuation means. Preferably, the controller is in the form of a software running on a computer having appropriate interfaces to control the actuators and/or valves controlling the actuators.

[0040] Further preferably, the controller comprises an algorithm enabling the platform to perform stochastic motion in select directions and with definable maximal translation distances and/or tilting angles. This allows designing personal therapies or training programs for any person, the programs being directed to the individual physical needs of the persons.

[0041] Further preferably, at least two wire-draw encoders are attached to said initial point, said encoders being connected to the controller. This allows a feedback to the controller on the position of the initial point. Therefore any misalignment of the initial point may be corrected by the controller based on the feedback generated by the at least two wire-draw encoders. The wires of the wire-draw encoders are preferably attached to the initial point such as to form an angle of 90° between both wires, whereby the wires lie in the motion plane of the initial point. This enables a precise detection of the position of the initial point within its plane of motion by the wire-draw encoders.

[0042] The at least three cables are preferably each deflected by means of at least one pulley arranged on said base plate between said first end and said second end, said deflection creating an angle in each of said cables. This allows leading the three cables from the pulleys to the initial point in a direction which is substantially parallel to the plane of movement of the initial point, thus facilitating the set-up of the device.

[0043] The fastening points of said cables to the underside of the platform and/or said arrangement of pulleys on said base plate are preferably movable such as to enable an independent variation in said angle of each of the cables by individually moving the fastening point and/or the pulley of each cable. This allows a variation in the proportion between tilting and translation in any movement of the platform induced by a movement of the initial point.

[0044] Other advantageous embodiments and combinations of features come out from the detailed description below and the totality of the claims.

Brief description of the drawings

[0045] The drawings used to explain the embodiments show:

Fig. 1 A schematic representation of an inventive device;

Fig. 2 a detailed view of a preferred configuration of the initial point;

Fig. 3 a detail of the support of the platform of the device as shown in Fig. 1;

Fig. 4 a representation of the underside of the platform;

Fig. 5 a detailed view of a pulley; and

Fig. 6 a detailed representation of a drive cable pulley.

[0046] In the figures, the same components are given the same reference symbols.

Preferred embodiments

[0047] Fig. 1 shows a perspective view of a schematic representation of an inventive device 1. The device 1 comprises a base structure 2 and a platform 3 which is movably arranged on the base structure 2 by means of a ball caster 4. Elements of the device 1 which would be hidden from the viewer by the platform 3 are represented in spotted lines. The ball caster 4 is connected with the base structure 2 by means of three support struts 5.1, 5.2, 5.3 arranged in the form of a tripod. The platform 3 is thereby spaced from the base structure 2 by a distance which is sufficient to allow unobstructed movement of the platform 3. The platform 3 is moved by means of three cables 6.1, 6.2, 6.3 attached at three distinct attachment points at the underside of the platform 3. The cables 6.1, 6.2, 6.3 are each deflected by a pulley 7.1, 7.2, 7.3 to an initial point 8 located between the support structure 2 and the ball caster 4. By moving the initial point 8 in a plane parallel to the support structure 2 it is possible to inflict to the platform 3 lateral translation in two directions about the ball caster 4 as well as tilting movements around two axes parallel to the plane of the platform 3, which is schematically exemplified by the arrows on the upper right corner of Fig. 1. The initial point 8 is moved by means of three drive cables 9.1, 9.2, 9.3 connected at a first end to the initial point 8 and at a second end to an actuator 10.1, 10.2, 10.3 each. The three drive cables 9.1, 9.2, 9.3 are further deflected by means of a respective drive cable pulley 11.1, 11.2, 11.3 which is located between the first end and the second end of the drive cables 9.1, 9.2, 9.3. The actuators 10.1, 10.2, 10.3 are linear actuators of the artificial muscle type. However, alternatively, the actuators 10.1, 10.2, 10.3 might also be other types of actuators enabling to exert a pulling and/or a pushing force on the drive cables 9.1, 9.2, 9.3, like hydraulic pistons, winches or even spring elements.

[0048] By moving the initial point 8 in the plane, the three cables 6.1, 6.2, 6.3 are also moved leading to a lengthening or shortening of the part of the cables 6.1, 6.2, 6.3 between the underside of the platform 3 and the respective pulley 7.1, 7.2, 7.3. Depending on the change in length of these parts of each of the three cables 6.1, 6.2, 6.3 it is possible to inflict the appropriate movement to the platform 3. Hence, by providing just three active linear actuators 10.1, 10.2, 10.3 it is possible to move the platform in four degrees of freedom. Such as to allow a controlled movement of the platform 3, an appropriate controller (not shown) is further provided, which allows a precise control of the three actuators 10.1, 10.2, 10.3.

[0049] Fig. 2 shows a detail of a preferred configuration of the initial point 8. The initial point 8 comprises a rigid ring 12, preferably made of steel or any other suitable metal. The three cables 6.1, 6.2, 6.3 are attached to the rigid ring 12 by means of one cable loop 13.1, 13.2, 13.3 each. These cable loops 13.1, 13.2, 13.3 are constituted of a first end of each of the cables 6.1, 6.2, 6.3 looping backwards around the rigid ring 12, wherein the looped back first ends are rigidly attached to the cables 6.1, 6.2, 6.3 by means of cable clamps 14.1, 14.2, 14.3. For reasons of simplicity, the three drive cables 9.1, 9.2, 9.3 are not shown on Fig. 2. However, the drive cables 9.1, 9.2, 9.3 may be attached to the rigid ring 12 of the initial point 8 in a similar manner as the three cables 6.1, 6.2, 6.3.

[0050] Fig. 3 shows a detail of the support of the platform 3. The support comprises three struts 5.1, 5.2, 5.3 which are arranged in the fashion of a tripod. At the top of this tripod arrangement, a holder 16 is arranged to which the upper ends of the three struts 5.1, 5.2, 5.3 are connected. The holder 16 is shown as a six sided element, however, the holder 16 might also have any other form suitable to attach the three struts 5.1, 5.2, 5.3 to it, such as e.g. round, triangular, etc. The three struts 5.1, 5.2, 5.3 are attached to the holder 16 by means of suitable connection elements, such as screws or bolts. A bearing 15 for the ball caster 4 is further arranged on the holder 16.

[0051] Fig. 4 is a representation of the underside of the platform 3. A bearing plate 17 is attached to said underside which serves as a reinforcement of the platform 3 in the area in contact with the ball caster 4. Further, the bearing plate 17 includes the attachment points 18.1, 18.2, 18.3 for the three cables 6.1, 6.2, 6.3. Such as to attach said cables 6.1, 6.2, 6.3 to the attachment points 18.1, 18.2, 18.3 each of these attachment points 18.1, 18.2, 18.3 comprises a shackle 19.1, 19.2, 19.3, preferably made of steel. The shackles 19.1, 19.2, 19.3 are attached to respective shackle holders 20.1, 20.2, 20.3 in a tilting manner. The shackle holders 20.1, 20.2, 20.3 are arranged on the bearing plate 17 and are preferably made of steel. The bearing plate 17 is preferably made of an abrasive resistant and rigid material, e.g. such as steel. As the bearing plate 17 will take most of the loads exerted on the platform 3, the platform 3 itself may be made of a less rigid material, such as wood for example.

[0052] Fig. 5 shows a pulley 7 in more detail. The pulley 7 comprises a support 26 which is attached to the base structure 2 of the device 1. A tension rod 24 is arranged through an opening of this support 26 in a swivable manner. To this tension rod 24 an arcuate bracket 23 is affixed, whereby the two ends of the bracket 23 pass through respective openings provided through the tension rod 24 on both sides of the support 26. The bracket 23 is secured against extraction from the openings of the tension rod 24 by means of two nuts 25.1, 25.2 threaded onto both ends of the bracket 23. Loosening or tensioning of the nuts 25.1, 25.2 allows to vary the tension exerted on a cable 6 deflected by the pulley 7. A roll frame 22 including two roll frame halves 22.1, 22.2 affixed together

attaches a roll 21 to the bracket 23. The roll 21 is thereby freely rotatable about an axis 27 between said two roll frame halves 22.1, 22.2. A cable 6 may be arranged on roll 21 such as to be deflected.

[0053] Fig. 6 is a detailed representation of a drive cable pulley 11. The drive cable pulley 11 comprises a drive cable pulley support 30 which may be attached to the base structure 2. A drive cable roll holder 28 comprised of two drive cable roll holder halves 28.1, 28.2 affixed together is attached to the drive cable pulley support 30 in a swivable manner by means of a set screw 29. The drive cable roll holder 28 is swivable around a swivel axis 31. A drive cable roll 33 is arranged freely rotatable around a rotation axis 32 between the two drive cable roll holder halves 28.1, 28.2.

Claims

1. Device for active movement of a person or object, the device comprising:

   a) a base structure (2);
   b) a platform (3) movably supported on the base structure (2) by means of a support (4), said support (4) being arranged between said base structure (2) and said platform (3) and being configured to allow a movement of said platform (3) in at least three degrees of freedom;
   c) at least three cables (6.1, 6.2, 6.3) fastened to an underside of said platform (3) at a first end;

   characterized in that the at least three cables (6.1, 6.2, 6.3) are fastened at a second end to a common initial point (8), said initial point (8) being freely movable at least in one plane by actuation means (9.1, 9.2, 9.3, 10.1, 10.2, 10.3).

2. Device according to claim 1, **characterized in that** said actuation means (9.1, 9.2, 9.3, 10.1, 10.2, 10.3) comprise at least two, preferably three drive cables (9.1, 9.2, 9.3) which are connected to the initial point (8) at a first end and to an actuator (10.1, 10.2, 10.3) at a second end.

3. Device according to claim 2, **characterized in that** said actuators (10.1, 10.2, 10.3) are linear actuators, preferably of the pneumatic muscle type.

4. Device according to any of claims 2 or 3, **characterized in that** the device (1) comprises three drive cables (9.1, 9.2, 9.3) which are connected to the initial point (8), said drive cables (9.1, 9.2, 9.3) being arranged such as to lead away of the initial point (8) at angles of approximately 120° one to each other.

5. Device according to any of claims 1 to 4, **characterized in that** said initial point (8) is arranged between said base structure (2) and said platform (3).

6. Device according to any of claims 1 to 5, **characterized in that** said support (4) is configured to allow a movement of said platform (3) in four degrees of freedom, preferably by allowing free translation and tilting of said platform about said support (4).

7. Device according to any of claims 1 to 6, **characterized in that** said support (4) is a ball caster.

8. Device according to any of claims 1 to 7, **characterized in that** the device (1) further comprises a controller for controlling said actuation means (9.1, 9.2, 9.3, 10.1, 10.2, 10.3).

9. Device according to claim 8, **characterized in that** said controller is configured such as to move said platform (3) to any combination of translation and/or tilting about the support (4) through a translation of said initial point (8) by means of the actuation means (9.1, 9.2, 9.3, 10.1, 10.2, 10.3).

10. Device according to any of claims 8 or 9, **characterized in that** at least two wire-draw encoders are attached to said initial point (8), said encoders being connected to the controller.

11. Device according to any of claims 1 to 10, **characterized in that** said at least three cables (6.1, 6.2, 6.3) are each deflected by means of at least one pulley (7.1, 7.2, 7.3) arranged on said base structure (2) between said first end and said second end, said deflection creating an angle in each of said cables (6.1, 6.2, 6.3).

12. Device according to claim 11, **characterized in that** said fastening of said cables (6.1, 6.2, 6.3) on the underside of the platform (3) and/or said arrangement of the pulleys (7.1, 7.2, 7.3) on said base structure (2) are movable such as to enable an independent variation in said angle of each of the cables (6.1, 6.2, 6.3) by individually moving the fastening and/or the pulley (7.1, 7.2, 7.3) of each cable (6.1, 6.2, 6.3).

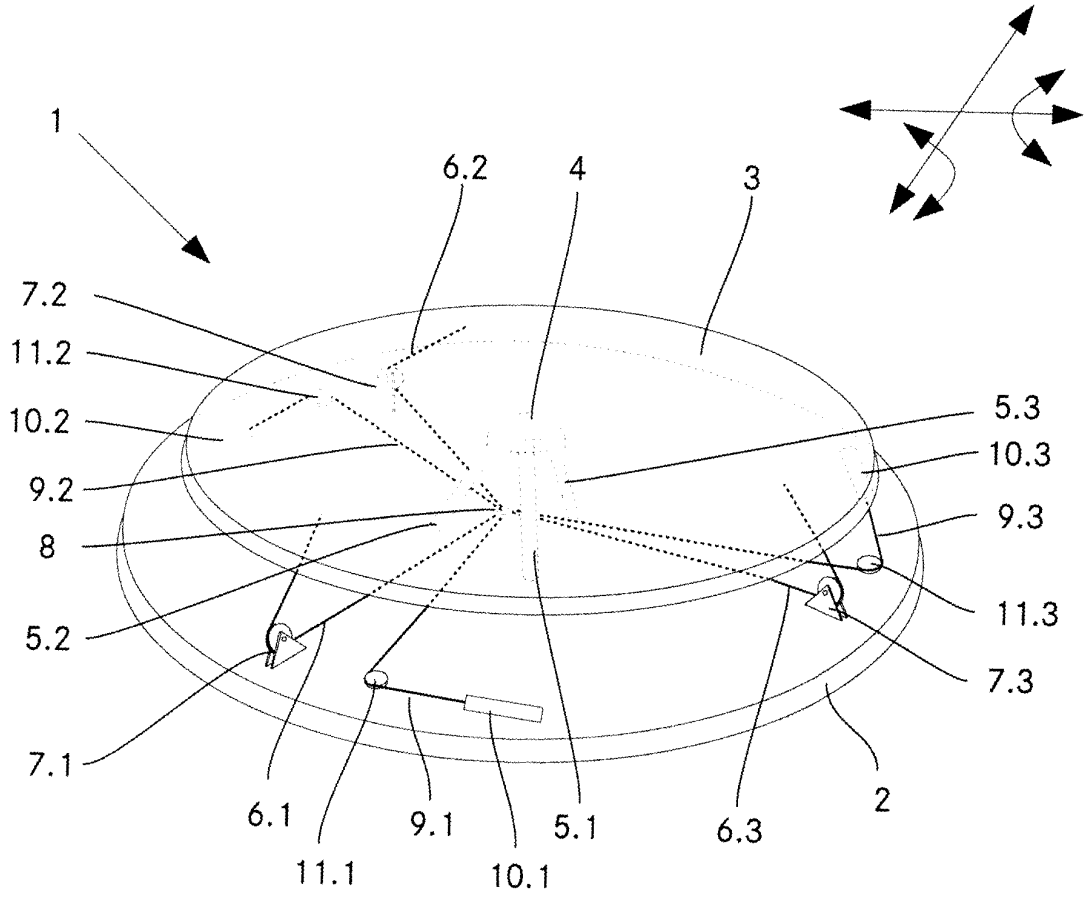

Fig. 1

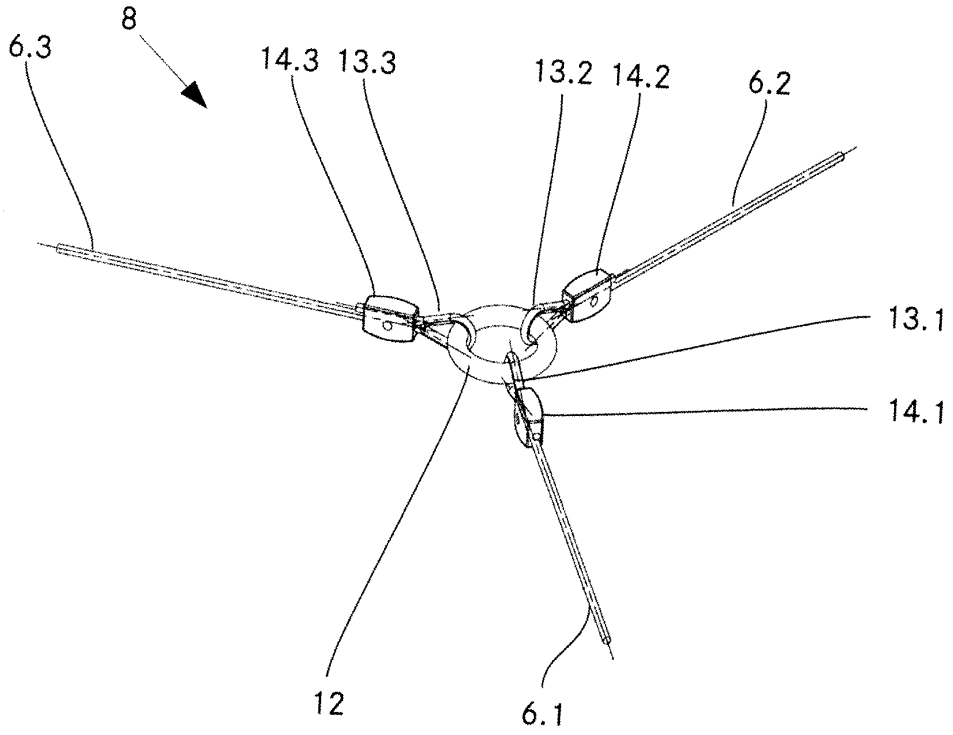

Fig. 2

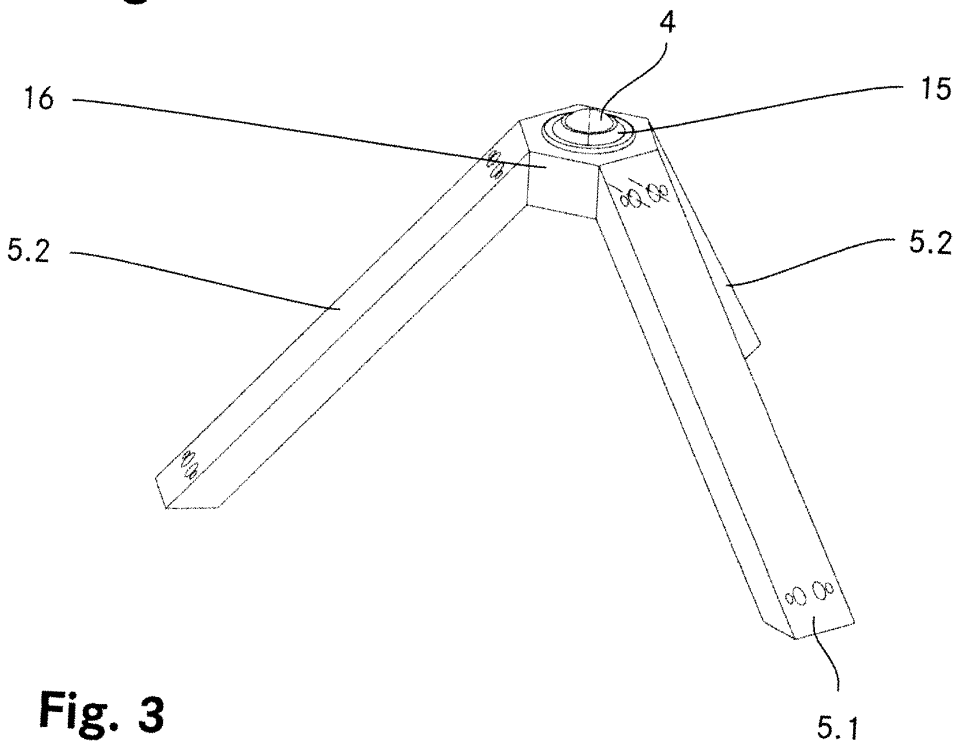

Fig. 3

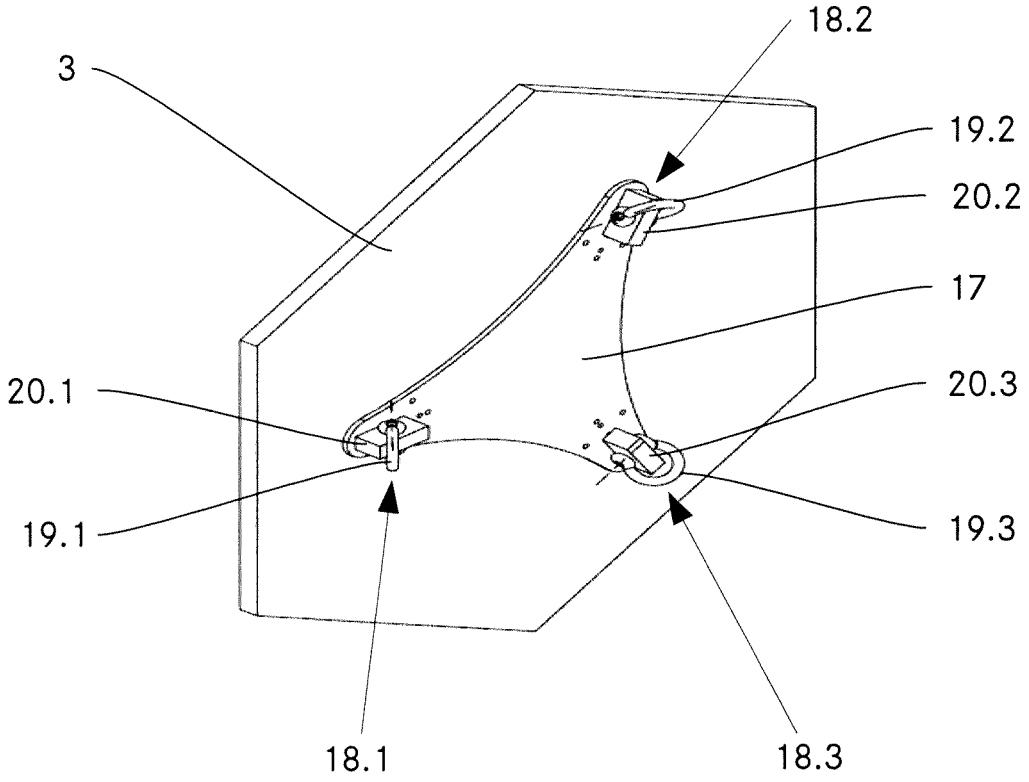
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Fig. 4

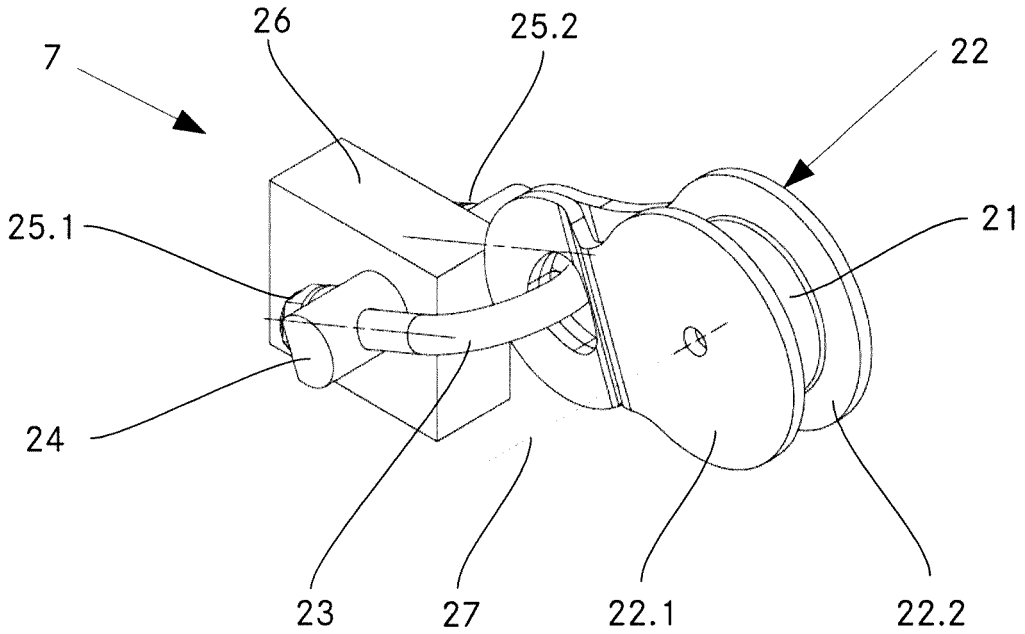
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Fig. 5

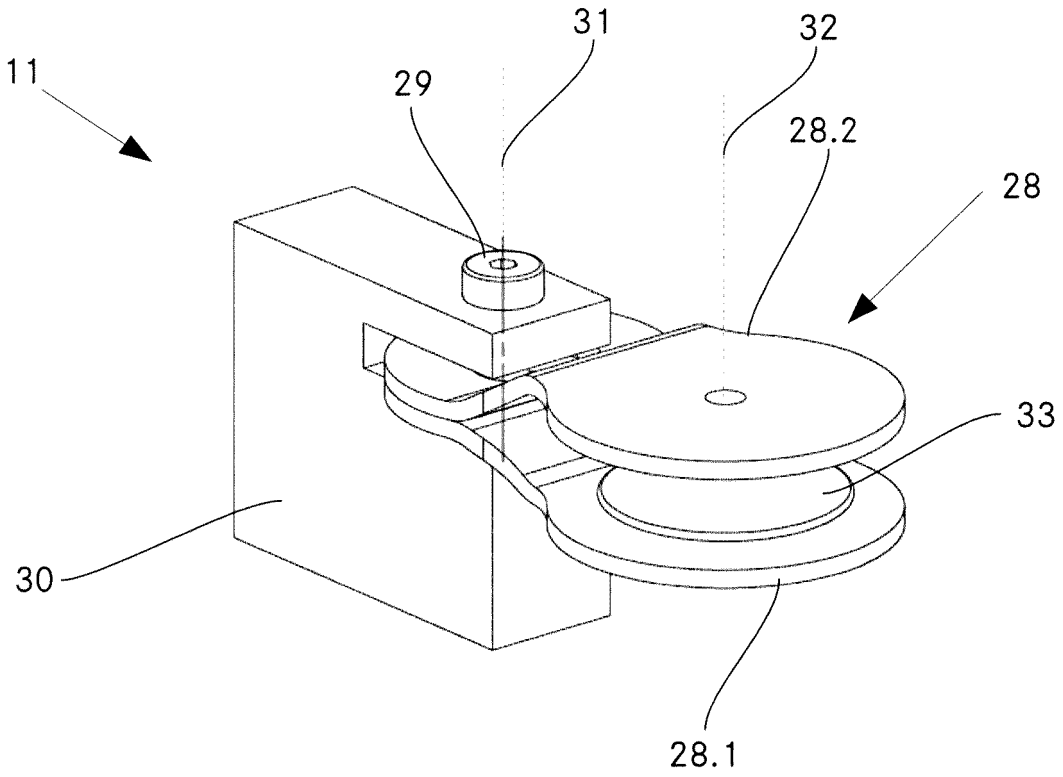

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 13 40 5113

DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 February 2014	Borrás González, E

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X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 40 5113

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