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(54) **Title**: CONTROLLED DESCENT DEVICE FOR LOWERING PEOPLE FROM AN ELEVATED POSITION

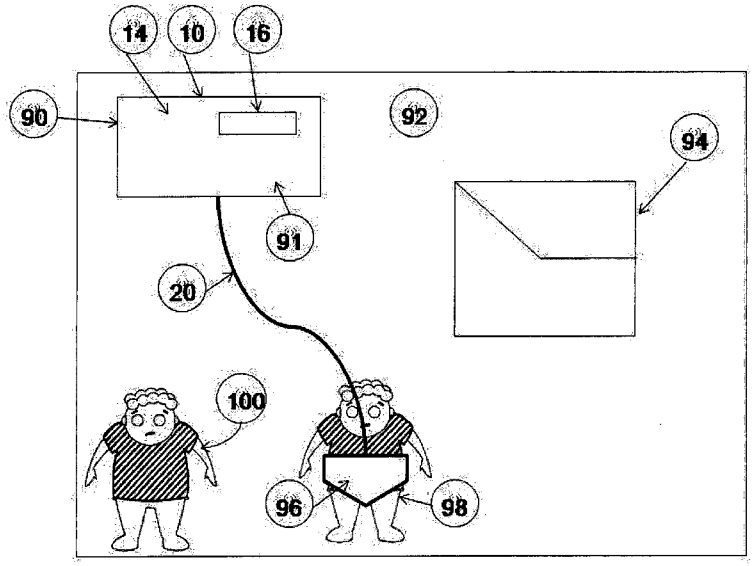


Fig 4A

(57) **Abstract**: A controlled descent device adapted for lowering people from an elevated position to a lowered position a predetermined distance therefrom at a constant velocity, the descent device comprising an axle, a descent unit mounted on the axle and adapted for rotational motion therearound, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity; the descent unit comprising a cylindrical member, a cable wound around the cylindrical member adapted for suspending the people during said lowering, an engagement mechanism mounted on the cylindrical member, and a rotation restriction mechanism.

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CONTROLLED DESCENT DEVICE FOR LOWERING PEOPLE FROM AN ELEVATED POSITION

FIELD OF THE INVENTION

This invention relates to a controlled descent device and method of use thereof for lowering people from an elevated position, and in particular to a controlled descent device for lowering people at a constant velocity.

BACKGROUND OF THE INVENTION

There are many known devices for lowering people during an emergency from an elevated position, such as a high floor of a tall building. Often these systems use cables to lower the people, who may be attached thereto via harnesses or elevator-like structures. To prevent the people being lowered at an accelerating velocity, due to the affects of gravity, normally a braking system is used to facilitate constant velocity of descent. The braking system may include a hydraulic or electric motor. Some example descent devices having at least some of these features are listed below.

US 4,616,735 disclose a fire escape device is disclosed for use in lowering persons from high-rise structures. The device comprises a frame having a spool rotatable mounted thereon, with a cable being wound around the spool. There is a first sprocket wheel fixed to the spool and a second sprocket wheel disposed on a fluid pump adjacent the spool. The first sprocket rotates as the cable is dispensed from the spool, thereby driving the small sprocket wheel on the fluid pump.

The small sprocket wheel is provided with means for moving fluid through a fluid circuit in which a pressure compensated flow control valve is disposed for maintaining a constant speed of revolution of the spool independently of the weight of a person being lowered to the ground by the cable being unwound from the spool. In some embodiments a fluid reservoir is provided in the fluid reservoir for cushioning shock waves and breaking up bubbles. A rescue collar attached to the cable can be stored in a box around the frame, the box having a trap door in the bottom through which the collar falls when a rip cord is pulled.

US 2004/0159494 disclose an automatic cable delivery system that can lower heavy weights from some heights with automatically controlled deceleration. This device is capable of sensing the amount of the load being lowered and therefore automatically adjust the resistance on a continuous basis thereby controls the descending speed to a desirable rate regardless of the weight. This automatic descending system is very useful during evacuation in case of emergency from high-rise building and similar structures. This unit is very portable and does not require any permanent fixture. This unit consists of a translucent clutch, hydraulic or mechanical, in conjunction with a unidirectional retractable cable spool coupled trough a planetary gear system. This unit is fitted with a retractor, which retracts the cable once it is released. This retraction is faster than the controlled release of the cable during lowering of load.

US 2005/0098383 disclose an escape device that comprises a sliding box worn by each escaping person, such that the escape device is combined with an escape cable. The sliding box comprises a supporting structure; a driven wheel supported in the structure for rotation, and adapted to be in engagement with the escape cable and to be driven thereby into rotation. The rotary speed correspond to the speed of the motion of the sliding box relative to the escape cable, and therefore, corresponds to the speed of descent of the escaping person; means for measuring the rotary speed of the driven wheel and therefore, the speed of descent of the escaping person; and braking means, for slowing the rotation of the driven wheel, and therefore the speed of descent of the escaping person, whenever it is required to maintain the speed of descent within predetermined limits.

US 4,287,963 discloses a safety apparatus for lowering one or more persons from a window or a hotel room or the like characterized by structural framework that is affixed inside the room and disposed adjacent the window, an extensible arm that is pivotally connected with the structural framework and having a free end that is pivotally moveable exteriorly of the window, a rotating drum having a lineal member disposed thereabout and connected therewith for controllably dispensing the member and any person at the end of the lineal member, sheaves suitably mounted with the lineal member traversing thereover, body harness means for holding the person or persons and connected with the lineal member, such as the cable, and means for controlling the rate of descent of the person without requiring a separate control cable, radio control with elaborate receiving equipment inside the room or the like.

US 4,653,609 discloses a controlled descent apparatus for lowering a person from an elevated place includes a cable which is wound on a drum and is unwound from the drum by the weight of the person to effect the descent. To limit the rate of descent, the drum turns as the cable is unwound and drives a positive displacement pump the output of which is through a flow control valve. The latter is set to permit a preselected maximum rate of flow so that the drum turns at a correlated maximum speed and thus limits the rate at which the cable is paid out during the descent. In the unlikely event that the valve fails to limit the speed of the drum, a centrifugally operated brake is automatically energized at a somewhat higher speed of the drum whereby the descent continues at a faster but still a safe rate. The cable is guided through an opening, such as a window, in an outside wall by an arm which is formed by inner and outer sections pivotally connected to each other with the inner arm pivotally connected relative to the wall so that the arm may be placed in a compact stored condition. To use the apparatus, the outer arm section first is swung down and latched to the inner arm section in a ready position and then the arm is swung to an active position in which the outer section projects through the window. The apparatus also includes alternative power and manual means to rewind the cable on the drum for the next descent.

US 4,520,900 disclose a personnel escape mechanism for emergency evacuation of a high-rise building. An escape support for personnel in the form of harnesses or a protective cage is suspended from a trolley, riding on a rail extending externally from the building. The escape support is suspended by cable from a constant speed rotationally braked cable payout mechanism mounted in the trolley. The support and trolley are impelled to the outside of the building through a frangible wall opening, and then lowered to a safe ground location by the braked cable pay-out mechanism. In a preferred embodiment of the invention, a steel cage is provided on wheels near window of safety glass. This cage is suspended from a cable wound on a cable drum, which is rotationally coupled to a hydraulic pump controlled by a restricted, closed loop flow path. The cable drum and pump are mounted in a trolley which rides on an I-beam projecting out of the building through the safety glass.

US 5,586,617 discloses a device for safely lowering persons from upright structures such as buildings during an emergency at a safe, predetermined speed of no more than about four feet per second irrespective of the weight of the person being lowered. The device has a drum about which a cable is wound, a gear pump driven by the drum via a reduction gear train, and a hydraulic circuit which includes the gear pump and a flow control valve which maintains a constant hydraulic fluid flow through the circuit irrespective of the weight of the person being lowered and, therefore, also irrespective of the fluid pressure generated by the pump during operation. The hydraulic circuit is in fluid communication with a hydraulic fluid tank having an exterior surface dimensioned to cool the hydraulic fluid and prevent its temperature from rising by more than about 200.degree. F. above the ambient temperature during operation of the device.

A handle can be used for manually rewinding the cable about the drum, and the hydraulic circuit includes a one-way branch line, controlled with a check valve, to permit countercurrent circulation of hydraulic fluid during the rewinding of the cable. The gear train causes the gear pump to rotate at a substantially higher rate of rotation than that of the drum to facilitate the control of the fluid flow in the hydraulic circuit. The increase in fluid volume results in improved flow control in the flow control valve.

It should be noted that in the specification and the claims, wherever the term 'cable' is used, it should be understood to refer to any elongated element capable of safely lowering people from an elevated position, such as a high strength fiber rope, cord, or strap/belt etc. Similarly, it should also be understood that the term 'constant velocity' is intended to be understood as velocity which is approximately constant, within a reasonable variance margin. Thus when it is said that a person is descending at a constant velocity, this is intended to mean that the person is not descending in a significantly accelerating manner, as would normally be caused by gravitational forces.

SUMMARY OF THE INVENTION

The present invention refers to a device for lowering people from an elevated position, and particularly to such device that may be used during an emergency such as a fire in a tall building.

In accordance with one aspect of the present invention, there is provided a controlled descent device adapted for lowering people from an elevated position to a lowered position a predetermined distance therefrom at a constant velocity, the descent device comprising an axle, a descent unit mounted on the axle and adapted for rotational motion therearound, and a braking system adapted to restrict rotational motion of the axle to the constant rotational velocity; the descent unit comprising a cylindrical member, a cable wound around the cylindrical member adapted for suspending the people during said lowering, an engagement mechanism mounted on the cylindrical member, and a rotation restriction mechanism; the engagement mechanism being adapted to engage the axle when rotated in a first direction and to disengage from the axle when rotated in a second direction; the rotation restriction mechanism being adapted to arrest rotation of the cylindrical member, when the cylindrical member is subjected to a torque below a predetermined threshold value; wherein lowering of said people, when attached to the cable, causes rotation of the cylindrical member in the first direction and the engagement mechanism engages the axle, which restricts the rotational speed thereof causing the people to descend at a constant velocity by restricting the rotational motion of the descent unit via engagement thereof with the axle.

The rotation restriction mechanism may be constituted by a friction unit, an electromagnetic unit, a pneumatic unit, or a hydraulic unit, etc. In the case where the rotation restriction mechanism is a friction unit, the friction unit may comprise a plate biased into engagement with the cylindrical member via springs. The springs may be calibrated to cause a friction force of about 100N as a result of said engagement of the cylindrical member and the plate.

The engagement mechanism may have different constructions. One possible construction is where the engagement mechanism may comprise a spur gear engaging the axle and at least one pawl having a radial projection adapted to engage the spur gear. The spur gear may be formed with unidirectional teeth. The spur gear and at least one pawl may be adapted to enable the engagement mechanism to engage the axle via the spur gear when rotated in a first direction and to disengage from the axle via the spur gear when rotated in a second direction. The engagement mechanism may further comprise a biasing spring for each one of the at least one pawls. The biasing spring may be adapted to normally bias the pawl into engagement with the spur gear and disengage the pawl from the spur gear when the cylindrical member is moved in said second direction or the axle is moved in the first direction but any torque which the cylindrical member is simultaneously subjected to has is lower than said predetermined threshold value.

The controlled descent device may further comprise at least one additional descent unit mounted on the axle. In a case where the controlled descent device has two descent units mounted on the axle the arrangement may be such that the axle has two opposing ends and said descent units mounted thereon are each disposed at one of the two opposing ends of the axle. It should however be noted that any number of descent units may be mounted on the axle, and that they may be placed at different positions therealong, in accordance with design requirements for a particular application.

At least another one of the advantages of the device having multiple descent units, is that multiple people, who may be experiencing fear or panic due to the situation and elevated position, may begin descent when ready to do so, i.e. when the persons body weight begins to descend. Thus one person who is experiencing less panic may help another person descend, and then descend himself afterwards or in parallel with the other person. Notably both people may descend, starting at the same or different times, but being lowered by a device having a single braking system. Similarly, a single braking system may be used to lower more than two people, each of which being able to descend simultaneously or separately from the other people being lowered by the device.

The braking system may be selected from the group including a hydraulic system, electric system, magnetic system and pneumatic system. In a case where the braking system is a hydraulic system is of a hydraulic type, the system may comprise a hydraulic braking motor, a fluid circuit, a constant flow valve mounted on the fluid circuit and an accumulator mounted on the fluid circuit. Additionally, the braking system may further comprise a braking piston for operation during hydraulic malfunction.

In accordance with a further aspect of the present invention, there is provided a controlled descent device for lowering a people from an elevated position to a lowered position a predetermined distance therefrom at a constant velocity, the descent device comprising an axle, at least two descent units mounted on the axle and adapted for rotational motion therearound independent of the other descent unit, and a braking system adapted to restrict rotational motion of the axle to a constant velocity; each descent unit comprising a cylindrical member, a cable wound around the cylindrical member adapted for suspending the people during said lowering, an engagement mechanism mounted on the cylindrical member, and a rotation restriction mechanism; the engagement mechanism being adapted to engage the axle when rotated in a first direction and to disengage from the axle when rotated in a second direction; the rotation restriction mechanism being adapted to arrest rotation of the cylindrical member, when the cylindrical member is subjected to a torque below a predetermined threshold value.

The controlled descent device according to this aspect may further comprise any of the features mentioned above regarding the first aspect of the invention.

According to another aspect of the present invention, there is provided a controlled descent device adapted for lowering people from an elevated position to a lowered position a predetermined distance therefrom, the descent device comprising an axle and a descent unit mounted on the axle and adapted for rotational motion therearound, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity, the descent unit comprising a cylindrical member and a cable wound around the cylindrical member adapted for suspending the people during said lowering, the cable having a length designed to be approximately at least twice that of the predetermined distance.

The cable may be formed with loops at a central portion thereof to allow a user to attach themselves thereto. Thus when a first user has been lowered from the elevated position via the cable to a lower position of safety, a second user may attach themselves via the loops to the cable and descend without the cable having to be rewound. Alternatively or additionally to the cable having loops, the controlled descent device may include a harness adapted to be worn by a user and attached to the cable.

The controlled descent device according to this aspect may further comprise any of the features mentioned above with respect to the other aspects.

According to yet a further aspect of the present invention, there is provided a method for lowering multiple people from an elevated position to a lowered position a predetermined distance therefrom using a controlled descent device, the descent device comprising an axle, at least two descent units mounted on the axle and adapted for rotational motion therearound independent of each other, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity; each descent unit comprising a cylindrical member, a cable wound around the cylindrical member adapted for suspending the people during said lowering, an engagement mechanism mounted on the cylindrical member, and a rotation restriction mechanism; the engagement mechanism being adapted to engage the axle when rotated in a first direction and to disengage from the axle when rotated in a second direction; the rotation restriction mechanism being adapted to arrest rotation of the cylindrical member, when the cylindrical member is subjected to a torque below a predetermined threshold value;

including the following steps:

a) attaching a first person to one of the at least two descent units via the cable thereof;

b) lowering the first person from the elevated position;

c) attaching a second person to one of the at least two descent units, not used by the first person, via the cable thereof; and

d) lowering the second person from the elevated position.

wherein either of steps (a) and (b) may be carried out simultaneously with step (c) or (d).

According to yet another aspect of the present invention, there is provided a method for lowering multiple people from an elevated position to a lowered position a predetermined distance away using a controlled descent device, the descent device comprising an axle and a descent unit mounted on the axle and adapted for rotational motion therearound, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity, the descent unit comprising a cylindrical member and a cable wound around the cylindrical member adapted for suspending the people during said lowering, the cable having a length designed to be approximately at least

twice that of the predetermined distance, including the following steps:

a) attaching a first person to the descent unit via the cable thereof;

b) lowering the first person from the elevated position to lowered position;

c) attaching a second person to a portion of the cable adjacent the descent unit; and

d) lowering the second person from the elevated position to the lowered position.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic perspective view of a controlled descent device comprising a single descent unit in accordance with the present invention;

Fig. 2A is a schematic perspective view of the descent unit in Fig. 1A, in an engaged state, and with an edge plate removed;

Fig. 2B is a schematic section along line A-A in Fig. 2A, with another edge plate removed;

Fig. 2C is a perspective view of the descent unit in Figs. 1-2B, with the descent unit removed from the axle;

Fig. 2D is a schematic perspective view the descent unit in Figs. 2A and 2B, with the pawls in a disengaged state;

Fig. 3 is a schematic view of a braking system;

Fig. 4A is a schematic view of a room equipped with the controlled descent device in Fig. 1, and a person about to descend from a window using same;

Fig. 4B is a schematic view of a building comprising the room in Fig. 4A, and a person that has descended therefrom;

Fig. 4C is a schematic view of the building in Fig. 4B, except that the controlled descent device of Fig. 1 has an alternative cable attached thereto;

Fig. 4D is a schematic view of a portion of the cable in Fig. 4C; and

Fig. 5 is a schematic perspective view of a further example of a controlled descent device in accordance with the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout several views, there is shown in Fig. 1, a controlled descent device generally designated by the numeral 10, for lowering people from an elevated position at a constant velocity.

The descent device 10 comprises a frame 11, an axle 12 rotatably mounted on the frame 11, a descent unit generally designated by the numeral 14, and a braking system generally designated by the numeral 16 adapted to restrict rotational motion of the axle 12 to a predetermined rotational velocity. The descent unit 14 is mounted on the axle 12 and is adapted for rotational motion therearound.

Referring now also to Figs. 2A-2D, the descent unit 14 comprises a cylindrical member 18, a cable wound 20 around and fixed at one end thereof (not shown) to the cylindrical member 18, an engagement mechanism generally designated by the numeral 22 mounted on the cylindrical member 18, and a rotation restriction mechanism 19 (Fig. 2C).

The cable 20 is adapted to bear a load of up to about 150kg. It should however be noted that a cable used with the present invention will be chosen in accordance with routine design practices and estimated loads and therefore may be chosen to support loads of different magnitudes. The cable is designed to be sufficiently long to allow a user to be lowered to a desired position. For example the cable may be slightly longer than the distance from the controlled descent device to the ground, to allow for the cases where the descent path is not straight, due to wind etc.

The cylindrical member 18 comprises a cylindrical portion 24, and two edge plates 26 (noting that in Fig. 1 both plates 26 can be seen, whereas in Figs. 2A, 2B and 2D only one plate 26 is shown) articulated to either side of the cylindrical portion 24. The edge plates 26 are formed with apertures 28 and slots 30, which may be used, for example to fix handles 32 (for example as seen in Fig. 4) thereto, and to secure the fixed one end of the cable 20 thereto (not shown). As can be seen best in Fig. 2B, the cylindrical portion 24 is formed with apertures 34 via which the edge plates 26 are fastened thereto, a central annular member 36 formed with a T-shaped cross section and central aperture 40, and with recesses 42.

The engagement mechanism 22 comprises two rings 44, each ring 44 being mounted on each side of the central annular member 36, two pawls 46 pivotally mounted on each ring 44 via fasteners 48, a biasing spring 50 fixed to each pawl 46, and two spur gears 52 rotatably mounted to each face of the cylindrical member 18 via a guide sleeve 54 (Fig. 2B) to which they are affixed.

Each pawl 46 has a first end 60 and a second end 64. The first end 60 is formed with an inward radial projection 56 for engaging the adjacent spur gear 52, and a longitudinal projection 58. The second end 64 is formed with an aperture 62. Additionally, the pawl 46 is formed with a central aperture (not seen) via which the fasteners 48 are secured thereto. The pawls 46 are arranged 180° apart. It should however be noted that even a single pawl and single spur gear may be sufficient to accomplish the same function, which will be described hereinafter, and that any number of pawls may be chosen as is deemed appropriate.

The rings 44 are formed with apertures 65 to receive the fasteners 48 and mechanical stoppers 66 adapted to halt excessive pivotal motion of the pawls 46 by arresting motion of the longitudinal projections 58, as seen for example in Fig. 2B.

Each biasing spring 50 is a tension spring, tethered, via an eye 68 formed at each end thereof, to bolts (70, 72) articulated to second end 64 of each pawl 46 and the corresponding adjacent recess 42 of the cylindrical portion 24. Each spring 50 biases the corresponding pawl 46 to be positioned such that it the radial projection 56 thereof is normally engaged with the teeth 74 of the adjacent spur gear 52. It should be understood that other types of springs may be used to bias the pawls 46 in this position, *mutatis mutandis*.

Each spur gear 52 is formed with unidirectional teeth 74 adapted to engage the radial projection 56 of the adjacent pawls 46, and with an internal projection 76. The internal projection 76 is adapted to mesh with a recess 77 (see Fig. 2C) formed in the axle 12, such that the axle 12 rotates together with the spur gears 52 and guide sleeve 54. Notably the guide sleeve 54 is formed with annular lips 78 (Fig. 2C) extending along both sides of the central annular member's 36 T-shaped cross section, for preventing sliding with respect thereto.

Referring now to Fig. 2C, the rotation restriction mechanism 19 comprises a friction plate 110 is mounted on the axle 12 via a central aperture thereof (not shown), and springs 118. The friction plate 110 is formed with a rubber annular projection 112 protruding from a first face 114 thereof, and with recesses (not shown) formed in an opposing face 116 thereof. The recesses are adapted to receive the springs 118 which bias the friction plate 110 away from an adjacent portion 120 of the frame 11. The friction plate 110 is further formed with a peripheral notch 122 adapted to receive a bolt 124 therethrough which extends from the frame 11. The bolt 124 prevents rotation of the friction plate 110 with respect to the frame 11. When the descent unit 14 is mounted on the axle 12, the friction plate 110 is biased thereagainst by the springs 118, causing the annular projection 112 to be pressed against the edge plate 26 proximate to the friction plate 110. Spring constants of the springs are calculated to bias the friction plate 110 against the adjacent edge plate 26 such that the descent unit is prevented from rotating, when subjected to a turning torque less than 100N to overcome the friction therebetween and to therefore begin rotating.

It has been calculated that this arrangement will allow the controlled descent device starts to safely lower loads of over 20 kg (e.g. a child), and will prevent the descent unit from rotating due to torque transmission by the axle 12, as will be explained further hereinafter.

Turning attention to Fig. 3, the braking system 16 comprises a hydraulic braking motor 80 sold under the trade name "DANFOSS OMR 315", a closed hydraulic fluid circuit 82 capable of holding at least 400cc of oil, a constant flow valve 84 including an integrated by-pass check valve sold under the trade name "WANDFLUE" which is mounted on the fluid circuit 82, a 250cc capacity accumulator 86 mounted on the fluid circuit 82, and a transmission system 87. The axle 12 is a part of the transmission system 87. The axle 12 has mounted thereon a sprocket (not shown, but similar to the sprocket 130 in Fig. 5) and the motion thereof is restricted by engagement with the braking motor 80 via chain 89 (see Fig. 2D) which is in turn controlled by the braking motor 80. Additionally, the braking system 16 further comprises a braking piston 88 for reducing motion during hydraulic malfunction.

This particular braking system 16 is designed to enable descent of a load of between 0-600kg at a constant velocity, however it should be noted that oil capacity is calculated in accordance with the design requirements of a system, and may therefore vary with the type of braking motor used, estimated load, type of fluid used, etc.

It should also be noted that due to the brief, likely one-time use of the controlled descent apparatus 10, the braking system 16 may be provided free of an oil tank, reducing the size of the braking system 16.

As can be seen in Fig. 4A, it is advantageous that the controlled descent device 10 is as small as possible. The device 10 may be contained in a storage unit 90 having an appearance not dissimilar from an air-conditioning unit. Such unit may be fastened to the floor or walls of a room, a roof, or on a wall outside of a building which is adjacent to a window, etc. In Fig. 4A, the unit 90 is fastened to a wall 92 above a window 94. The unit 90 may be formed with a space 91 for storing a harness 96 via which a user 98 may attach himself to the cable 20.

In operation, the user 98 is located at an elevated position and opens the storage unit 90 and attaches himself to the cable 20 via the harness 96. Upon exiting the window 94, the user begins to descend and the cable 20 causes rotation of the descent unit 14 and hence the cylindrical portion 18 and engagement mechanism 22. Notably, the users weight causes a torque on the cylindrical member 18, via the cable 20, causing the rotation thereof. The magnitude of force caused by the user's 98 weight is sufficient to overcome the friction force between the cylindrical member 18 and the rotation restriction mechanism 19 which is adapted to arrest rotation of the cylindrical member below a predetermined threshold value of about 100N. The descent unit 14, thus rotates around the axle 12, with the pawls 46 engaging the spur gear 52 as show in Fig. 2A. The rotational motion of the descent unit is thus restricted to the constant velocity allowed by the braking system 16. This restriction is accomplished by the braking motor 80 impeding the turning motion of the axle 12 via the transmission system 87.

The torque produced by the motion of the cylindrical member 18 is opposed by oil (not shown) present in the motor 80, causing the oil to begin moving through the fluid circuit 82 and consequently slowing the cylindrical member's 18 motion. However, continuous gravitational forces on the user 98, would accelerate the oil in the fluid circuit 82 to eventually unacceptably high speeds, were it not for the constant flow valve 84 which acts to regulate the speed of the oil in the fluid circuit 82. The accumulator 86 ensures that oil is sufficiently supplied to the braking motor 80. Thus, the user 98 is lowered at a constant velocity.

Turning now to Fig. 4B, once the user 98 has reached an acceptable lowered position, e.g. on the ground 99 outside of a building, the user may then remove the harness 96 and the cable 20 may be rewound for additional use by another user 100 (Fig. 4A), noting that the unidirectional teeth 74 of the spur gear 52 allow the cable to be quickly rewound around the cylindrical portion 18 without engagement of the pawls 46 with the spur gear 52 preventing such. During rewinding the cylindrical member 18 moves in a counterclockwise direction and therefore pawls 46 disengage from the spurs 52, as seen in Fig. 2D.

Reverting to Fig. 4A, the wind may cause the user 98 to descend to a position slightly distant from the building 101 from which he descended, as shown, and such a cable having a length longer than the height H of the window 94 above the ground 99 may be necessary.

Since there may not be sufficient time for the cable 20 to be rewound to allow another person to descend, an alternative cable 20' is shown in Fig. 4C. The cable 20' has a length of about twice height H. For example the height of the window and hence estimated height of the controlled descent device when installed may be about 100 meters above the ground level, therefore the cable will have a length greater than 200 meters and the loops may be integrated into the cable at a the center point thereof plus or minus about 10 meters, i.e. from about 90 to 110 meters from the first end of the cable. Cable 20' comprises connection points 21 of any suitable type, e.g. loops (Fig. 4D), located at about half the length thereof to allow way across to allow user 100 to attach thereto, when the first user 98 reaches the ground, and descend, without having to rewind the cable. In such case, the device may further comprise a harness adapted to latch onto the loops 21. In a device where the cable does not comprise loops, or alternatively, if a user wishes to attach to a cable at a portion thereof that does not have loops, the device may comprise a harness adapted to fasten to the cable. Such fastening may be done by the harness having a clamp-like member attached thereto.

It should be noted that a safety factor may be added in, causing the length of the cable to be significantly greater than twice the height H. Furthermore, it is clear that the length of the cable may be increased to three or more times the height H, if such device were to be designed to allow a further user(s) to descend in series using the same cable.

Referring now to Fig. 5, there is seen a further example of a controlled descent device 102 adapted to lower at least two people independently.

The device 102 is similar to device 10, except that it has two descent units 14 mounted on two opposing ends (104, 106) of the axle 12.

During operation of device 102, a first person may help a second person become attached to the cable 20 of one descent unit 14, and help them to descend with the device 102, which works in a similar manner to that described above with respect to device 10. It should however be noted that during descent of the second person, the restriction rotation mechanism 19 prevents rotational motion of the descent unit 14 which has not yet been used, and rotation of the axle 12 caused by the descent of the first person only causes the spurs 52 of the stationary descent unit 14 to rotate. The rotation of the spurs 52, however, does not affect the adjacent cylindrical member 18, since the biasing force of the restriction rotation mechanism 19 against the cylindrical member 18 is greater than the friction force of the teeth 74 of the spurs 52 against the projections 56 of the pawls 46. Thus the yet to be used descent unit 14 is in, what could be described as a 'disengaged state' as shown in Fig. 2D. The disengagement of the pawls 46 allows the first person, who has not yet descended, to descend at any chosen time, for example together with the first person (simultaneously), while the first person is still descending, or after the first person has completed their descent. After completing his descent, the first person may attach themselves to the cable 20 of the other descent unit 14, and descend simultaneously, during or after descent of the second person.

One of the obvious benefits of such arrangement is that a person undergoing panic may be helped by someone who is more calm, as the calmer person will know that they can descend afterwards as quickly as needed. A further benefit is that the second person can descend together with the first person and calm them during the descent, as both will descend at the same speed. An additional benefit is that a person may connect themselves via a harness or otherwise to a cable, but may begin their descent only when they have succeeded to overcome their fear of exiting a window at a high location.

Those skilled in the art to which this invention pertains will readily appreciate that numerous changes, variations and modifications can be made without departing from the scope of the invention mutatis mutandis. For example, while a pawl/spur gear arrangement with unidirectional teeth has been described as an example, it should be appreciated that any device that allows a unidirectional arrangement where rotational velocity of a cylindrical member is restricted when the cylindrical member is rotated in one direction only, may also be used. A further example being that the rotation restriction mechanism may not only be friction based, but may restrict motion of the cylindrical member via an electromagnetic unit or any other motion impeding device. It should also be clear that while the descent units have been shown disposed at one end of an axle, or both ends thereof, they may be disposed anywhere along an axle, and not necessarily in a symmetric arrangement. It should be understood that the number of descent units may be increased, allowing multiple people to be lowered from such device in parallel and independently of each other. There may be any desired number of descent units placed on an axle, in accordance with the necessary design considerations for strength of the axle, frame and connection of the device to the building, etc. Additionally, the device may be built such that a single cable may also be strong enough to lower more than a single person.

CLAIMS:

1. A controlled descent device adapted for lowering people from an elevated position to a lowered position a predetermined distance therefrom at a constant velocity, the descent device comprising an axle, a descent unit mounted on the axle and adapted for rotational motion therearound, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity; the descent unit comprising a cylindrical member, a cable wound around the cylindrical member adapted for suspending the people during said lowering, an engagement mechanism mounted on the cylindrical member, and a rotation restriction mechanism; the engagement mechanism being adapted to engage the axle when rotated in a first direction and to disengage from the axle when rotated in a second direction; the rotation restriction mechanism being adapted to arrest rotation of the cylindrical member, when the cylindrical member is subjected to a torque below a predetermined threshold value; wherein during descent of said people, when attached to the cable, causes rotation of the cylindrical member in the first direction and the engagement mechanism engages the axle, which restricts the rotational speed thereof causing the people to descend at a constant velocity by restricting the rotational motion of the descent unit via engagement thereof with the axle.

The controlled descent device of Claim 1, wherein the rotation restriction mechanism is selected from the group including a friction unit, an electromagnetic unit, a pneumatic unit, or a hydraulic unit.

2. The controlled descent device of Claim 2, wherein said rotation restriction mechanism is a friction unit comprising a plate biased into engagement with said cylindrical member via springs to prevent motion of the cylindrical member below said predetermined threshold value.

3. The controlled descent device of Claim 3, wherein said springs are adapted to cause a friction force of about 100N as a result of said engagement of the cylindrical member and the plate.

4. The controlled descent device of Claim 1, further comprising at least one additional descent unit mounted on the axle.

5. The controlled descent device of Claim 5, wherein said axle has two opposing ends and said descent units mounted thereon are each disposed at one of the two opposing ends of the axle.

6. The controlled descent device of any one of Claims 1 to 6, wherein said engagement mechanism comprises a spur gear engaging the axle and at least one pawl having a radial projection adapted to engage the spur gear.

7. The controlled descent device of Claim 7, wherein said spur gear is formed with unidirectional teeth adapted to enable the engagement mechanism to engage the axle via the spur gear when rotated in a first direction and to disengage from the axle via the spur gear when rotated in a second direction.

8. The controlled descent device of Claims 7 or 8, wherein said engagement mechanism further comprises a biasing spring for each one of the at least one pawls, the biasing spring being adapted to normally bias the pawl into engagement with the spur gear and disengage the pawl from the spur gear when the cylindrical member is moved in said second direction or the axle is moved in the first direction but any torque which the cylindrical member is simultaneously subjected to has is lower than said predetermined threshold value.

9. The controlled descent device of Claim 9, wherein said braking system is selected from the group including a hydraulic system, electric system, magnetic system and pneumatic system.

10. The controlled descent device of Claim 10, wherein said braking system is a hydraulic braking system comprising a hydraulic braking motor, a fluid circuit, a constant flow valve mounted on the fluid circuit and an accumulator mounted on the fluid circuit.

11. The controlled descent device of Claim 11, wherein said braking system further comprises a braking piston for operation during hydraulic malfunction.

12. The controlled descent device of Claim 1, wherein said cable has a length approximately twice that of the predetermined distance.

13. The controlled descent device of Claim 13, wherein said cable is formed with loops at a central portion thereof.

14. A controlled descent device for lowering a people from an elevated position to a lowered position a predetermined distance therefrom at a constant velocity, the descent device comprising an axle, at least two descent units mounted on the axle and adapted for rotational motion therearound independent of the other descent unit, and a braking system adapted to restrict rotational motion of the axle to a constant velocity; each descent unit comprising a cylindrical member, a cable wound around the cylindrical member adapted for suspending the people during said lowering, an engagement mechanism mounted on the cylindrical member, and a rotation restriction mechanism; the engagement mechanism being adapted to engage the axle when rotated in a first direction and to disengage from the axle when rotated in a second direction; the rotation restriction mechanism being adapted to arrest rotation of the cylindrical member, when the cylindrical member is subjected to a torque below a predetermined threshold value.

15. A controlled descent device adapted for lowering people from an elevated position to a lowered position a predetermined distance away, the descent device comprising an axle and a descent unit mounted on the axle and adapted for rotational motion therearound, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity, the descent unit comprising a cylindrical member and a cable wound around the cylindrical member adapted for suspending the people during said lowering, the cable having a length designed to be approximately at least twice that of the predetermined distance.

16. The controlled descent device of Claim 16, wherein said cable is formed with loops at a central portion thereof.

17. The controlled descent device according to Claim 15 or Claim 16, further comprising a harness adapted to be worn by a user and attached to the cable.

18. A method for lowering multiple people from an elevated position using a controlled descent device, the descent device comprising an axle, at least two descent units mounted on the axle and adapted for rotational motion therearound independent of each other, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity; each descent unit comprising a cylindrical member, a cable wound around the cylindrical member adapted for suspending the people during said lowering, an engagement mechanism mounted on the cylindrical member, and a rotation restriction mechanism; the engagement mechanism being adapted to engage the axle when rotated in a first direction and to disengage from the axle when rotated in a second direction; the rotation restriction mechanism being adapted to arrest rotation of the cylindrical member, when the cylindrical member is subjected to a torque below a predetermined threshold value; including the following steps:

a) attaching a first person to one of the at least two descent units via the cable thereof;

b) lowering the first person from the elevated position;

c) attaching a second person to one of the at least two descent units, not used by the first person, via the cable thereof; and

d) lowering the second person from the elevated position.

wherein either of steps (a) and (b) may be carried out simultaneously with step (c) or (d).

19. A method for lowering multiple people from an elevated position to a lowered position a predetermined distance away using a controlled descent device, the descent device comprising an axle and a descent unit mounted on the axle and adapted for rotational motion therearound, and a braking system adapted to restrict rotational motion of the axle to a constant rotational velocity, the descent unit comprising a cylindrical member and a cable wound around the cylindrical member adapted for suspending the people during said lowering, the cable having a length designed to be approximately at least twice that of the predetermined distance, including the following steps:

e) attaching a first person to the descent unit via the cable thereof;

f) lowering the first person from the elevated position to lowered position;

g) attaching a second person to a portion of the cable adjacent the descent unit; and

h) lowering the second person from the elevated position to the lowered position.

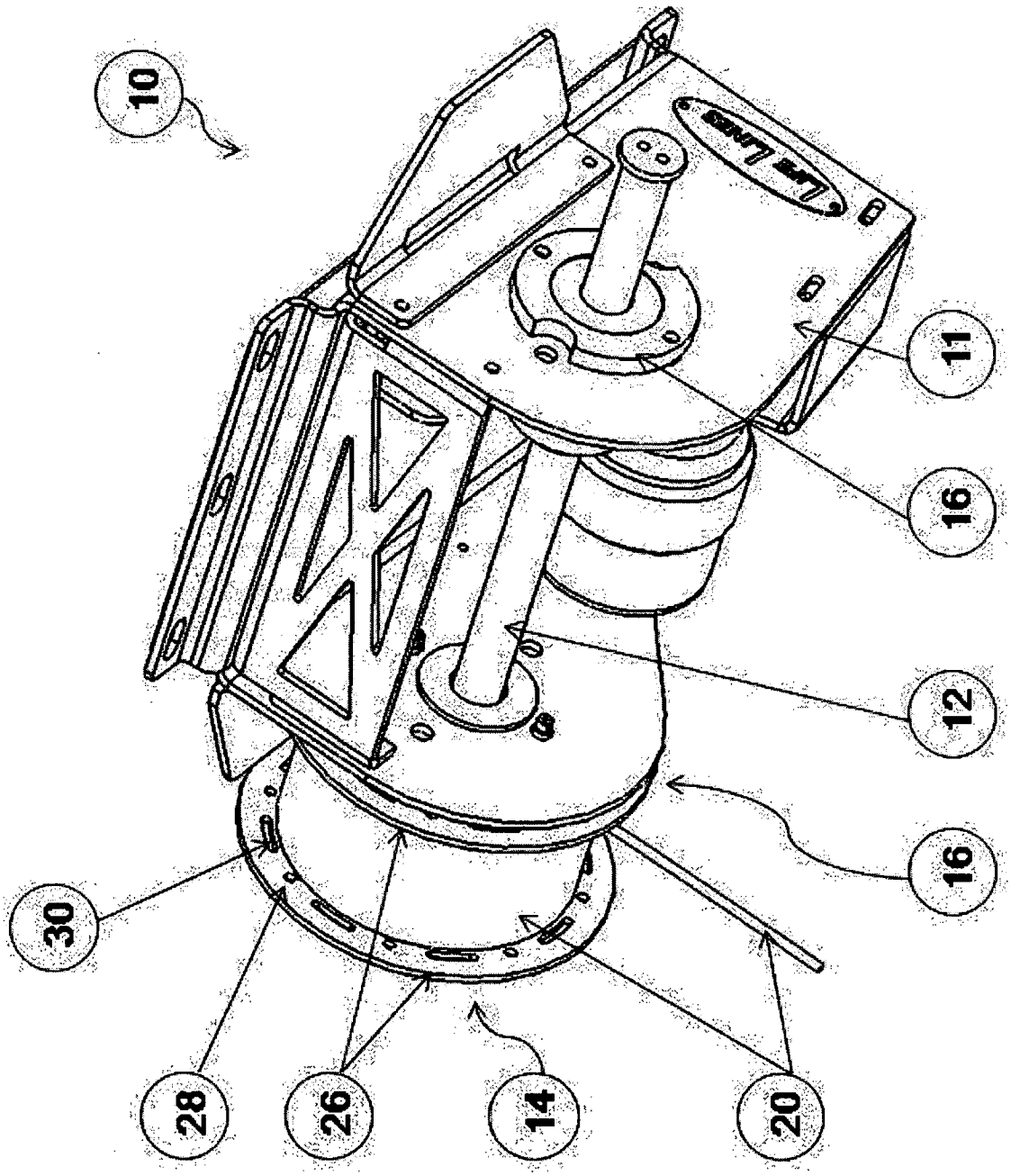


Fig 1

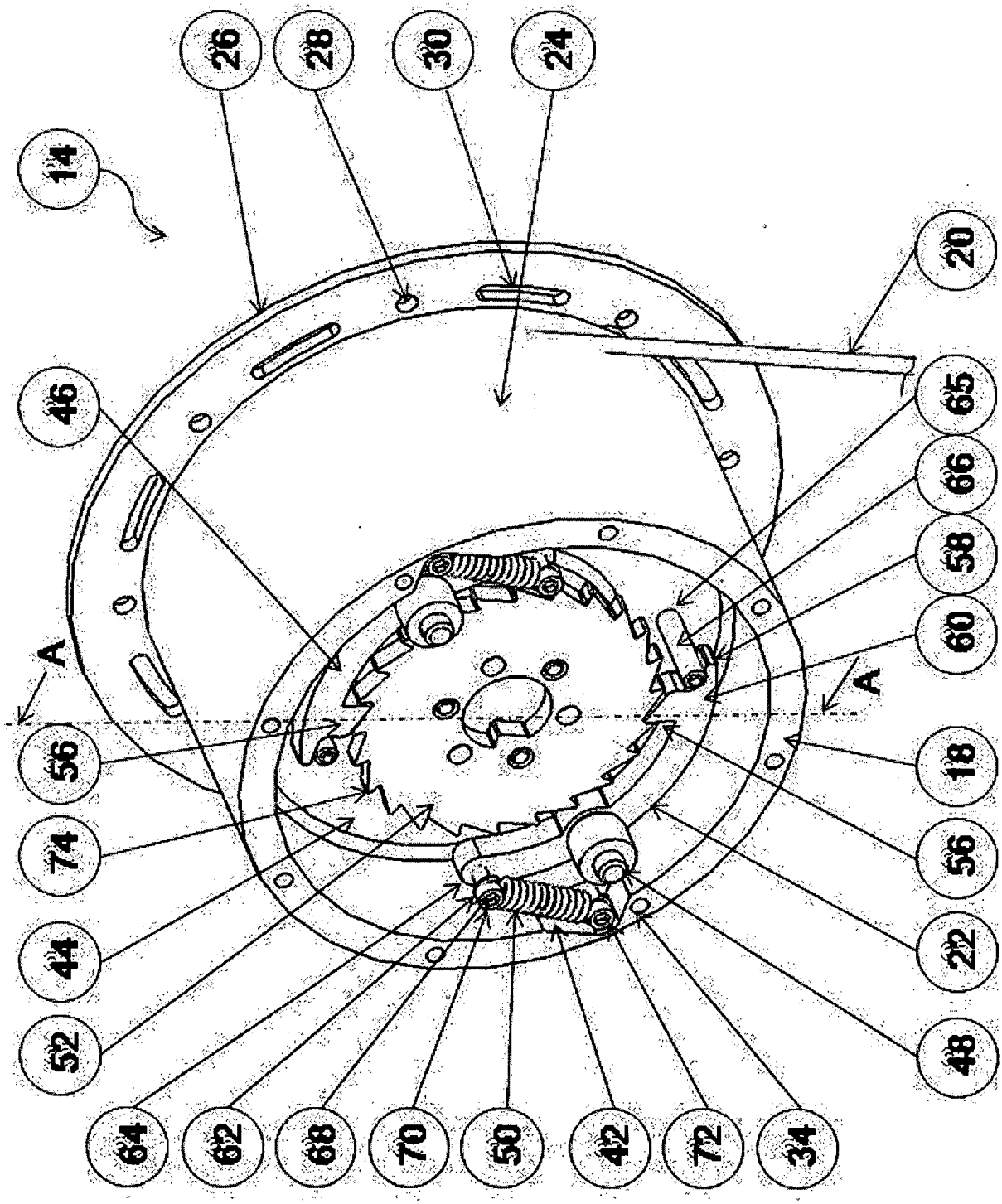

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Fig 2A

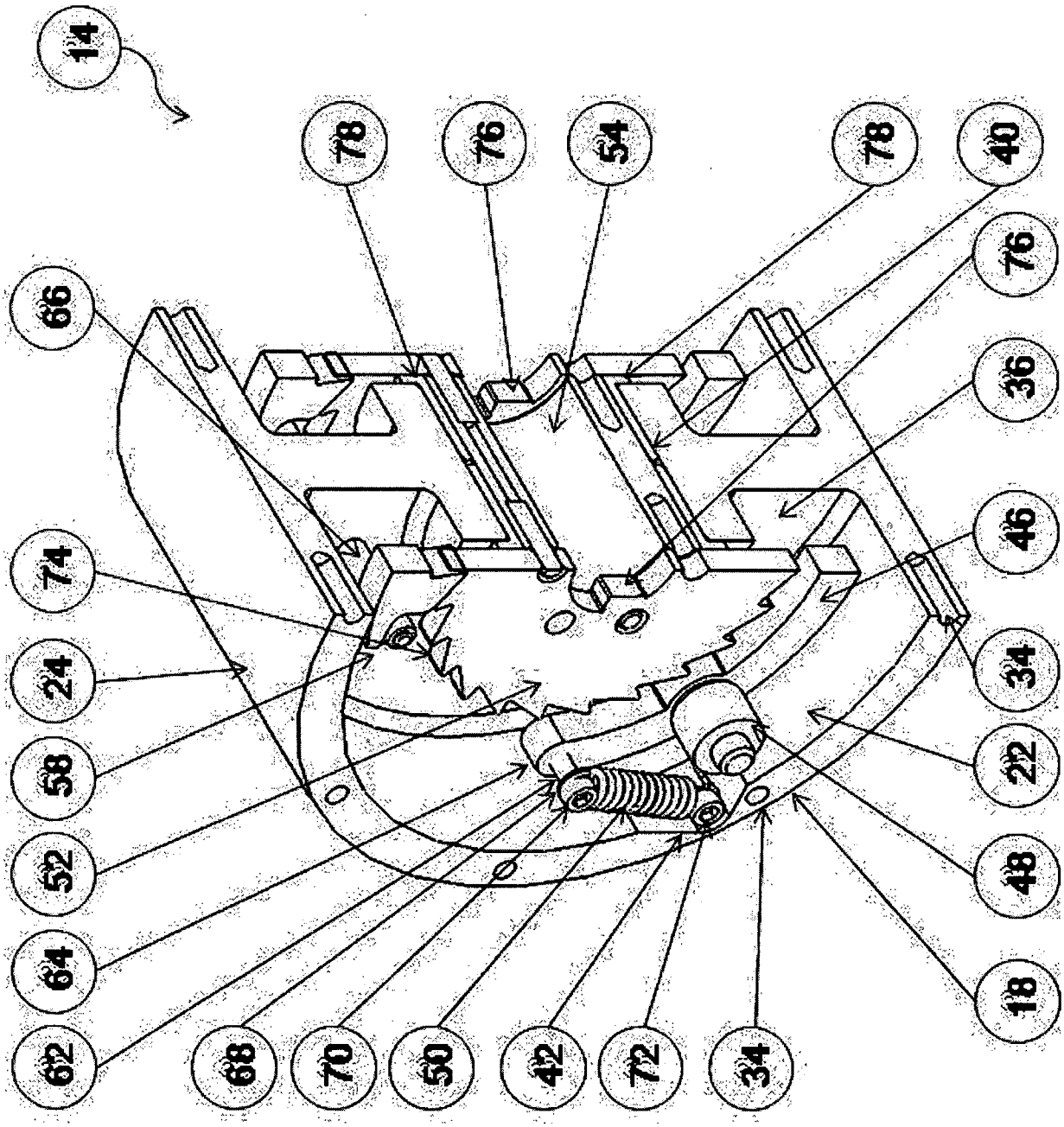

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Fig 2B

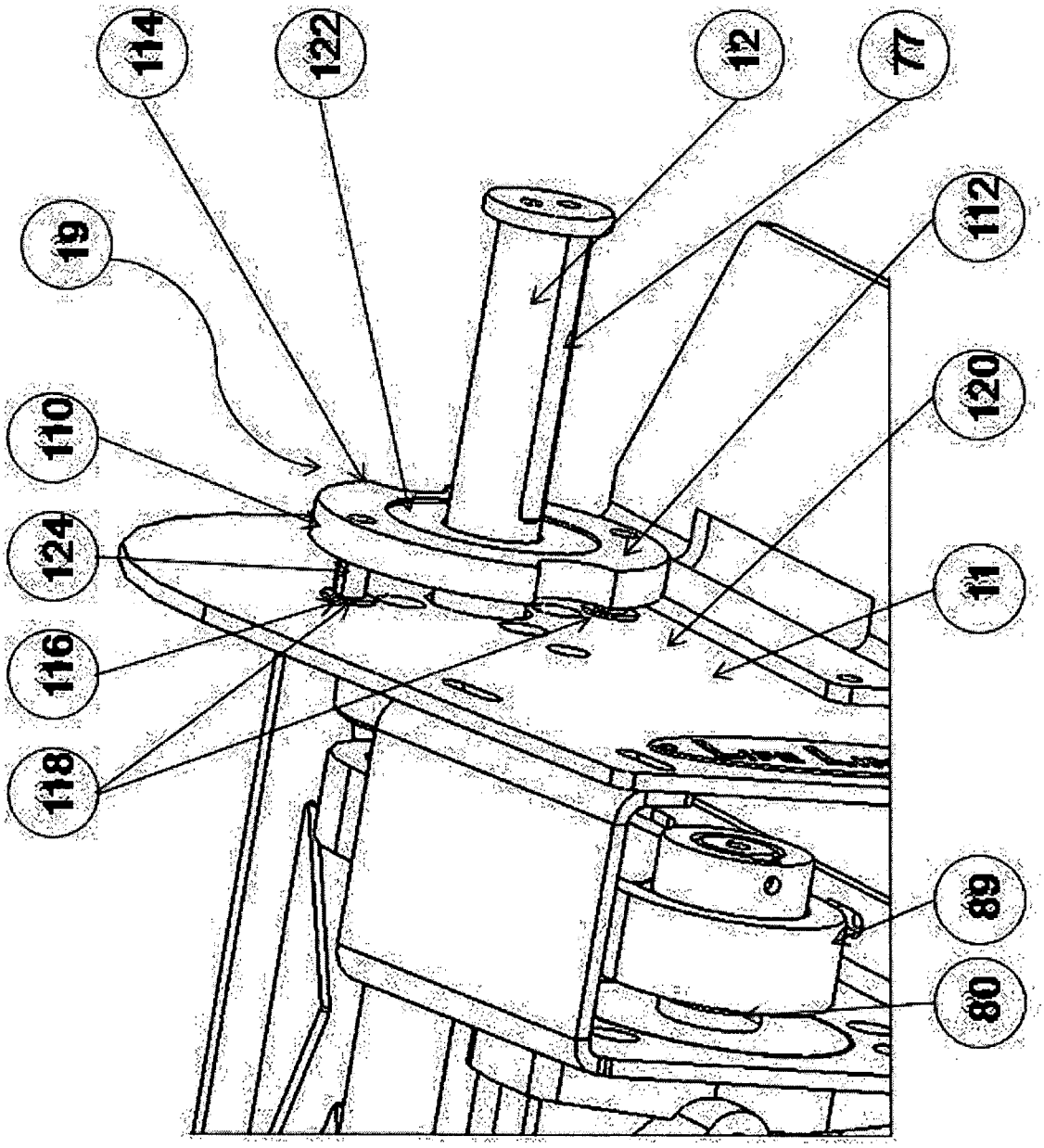


Fig 2C

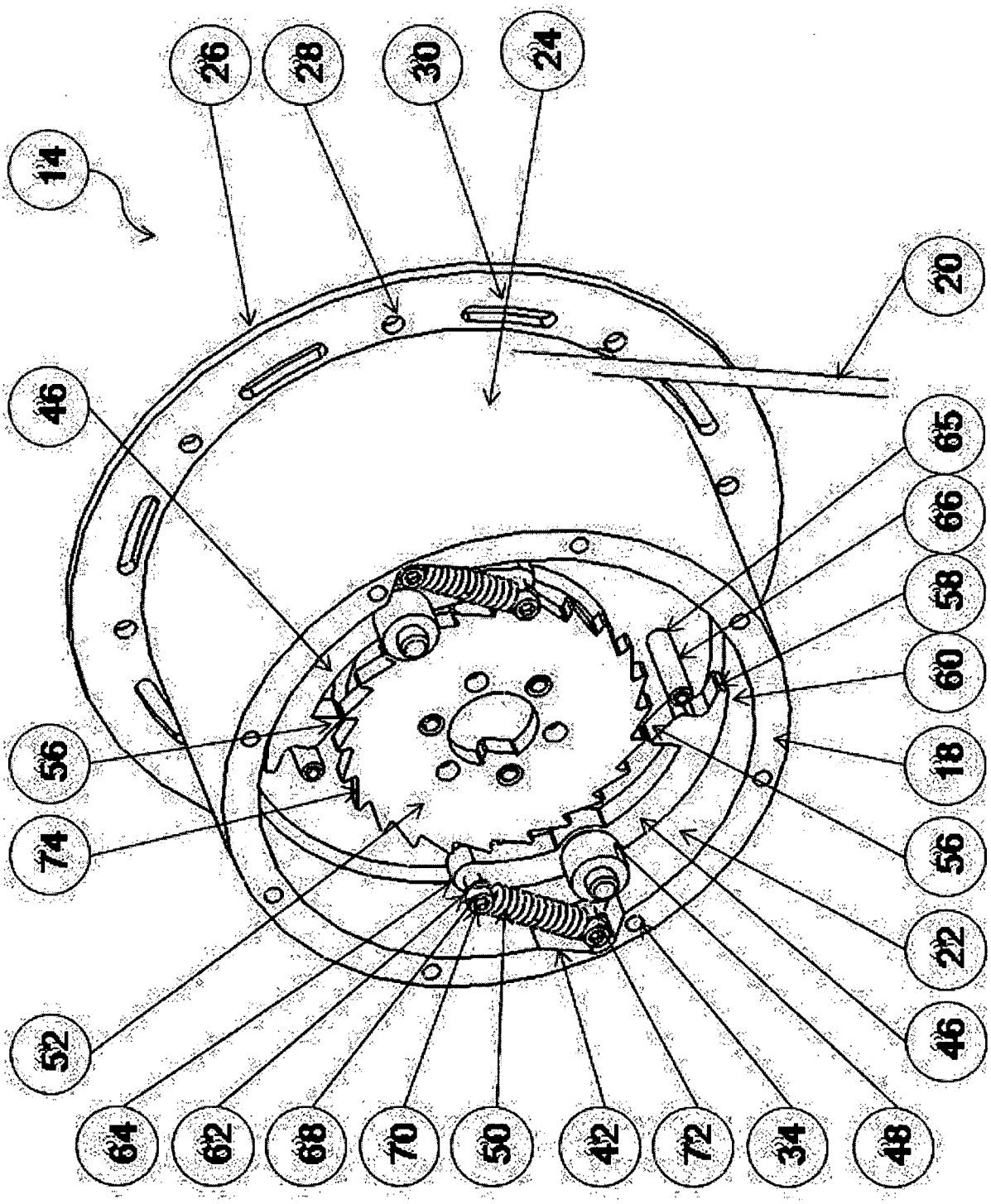

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Fig 2D

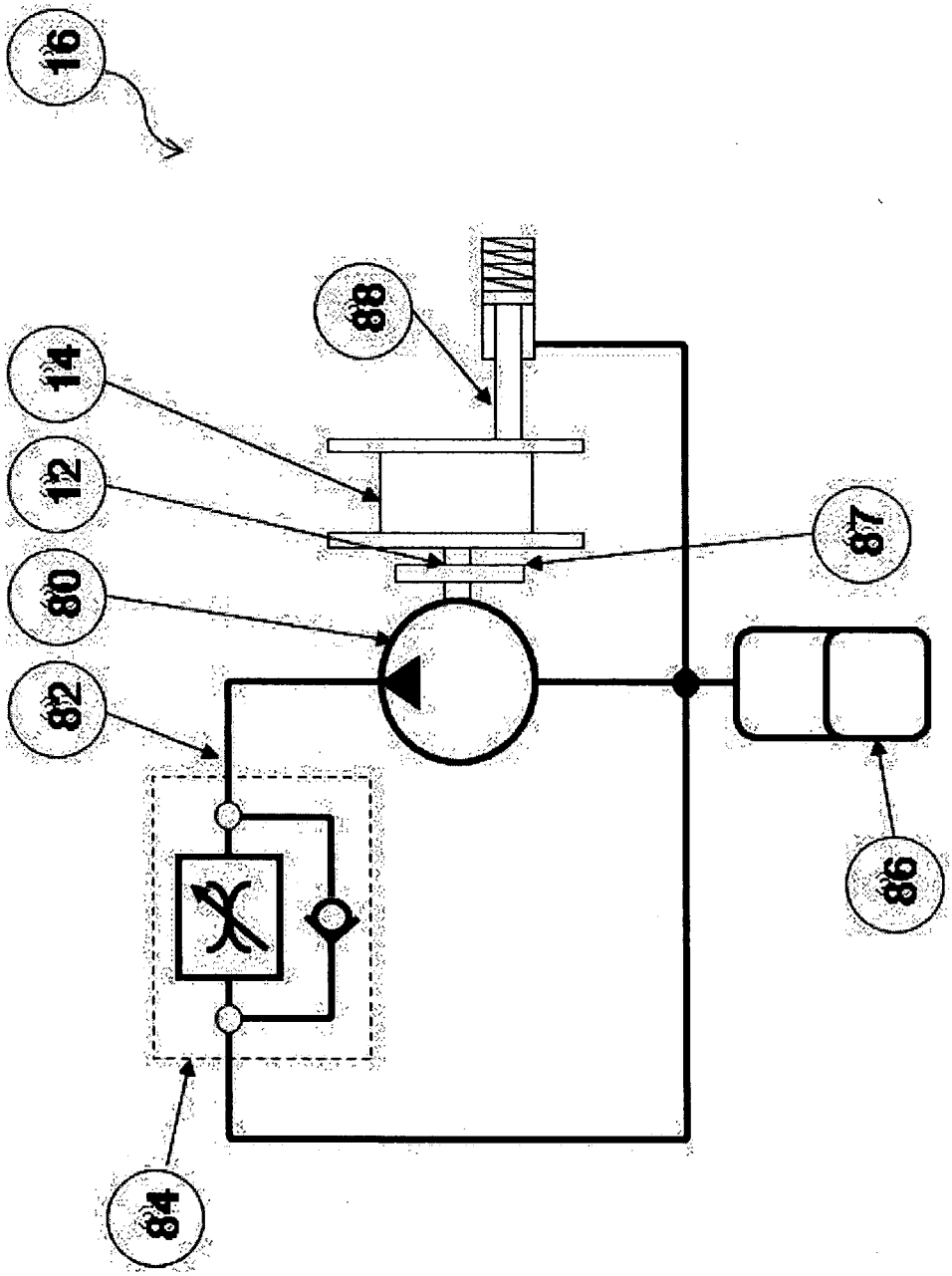


Fig 3

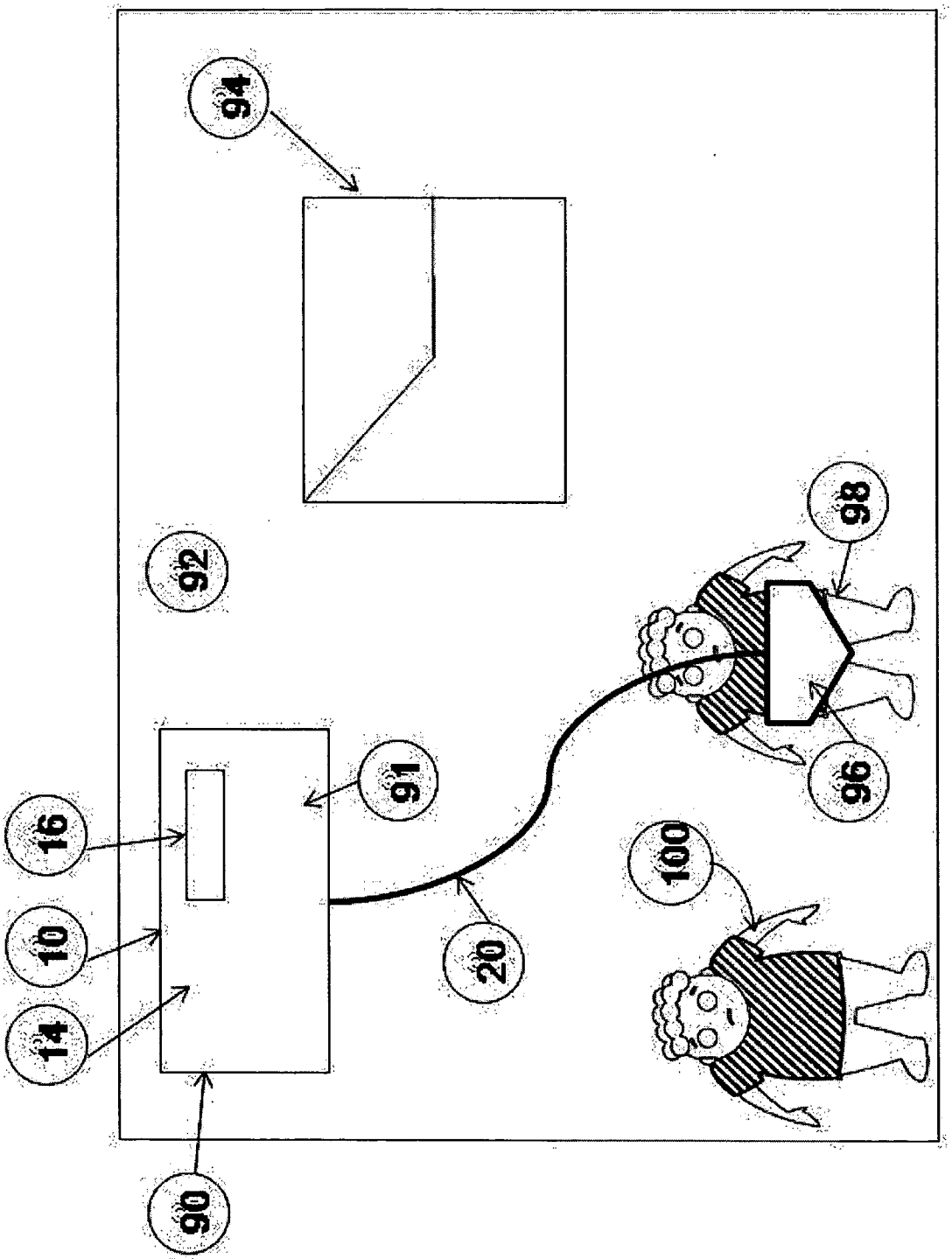


Fig 4A

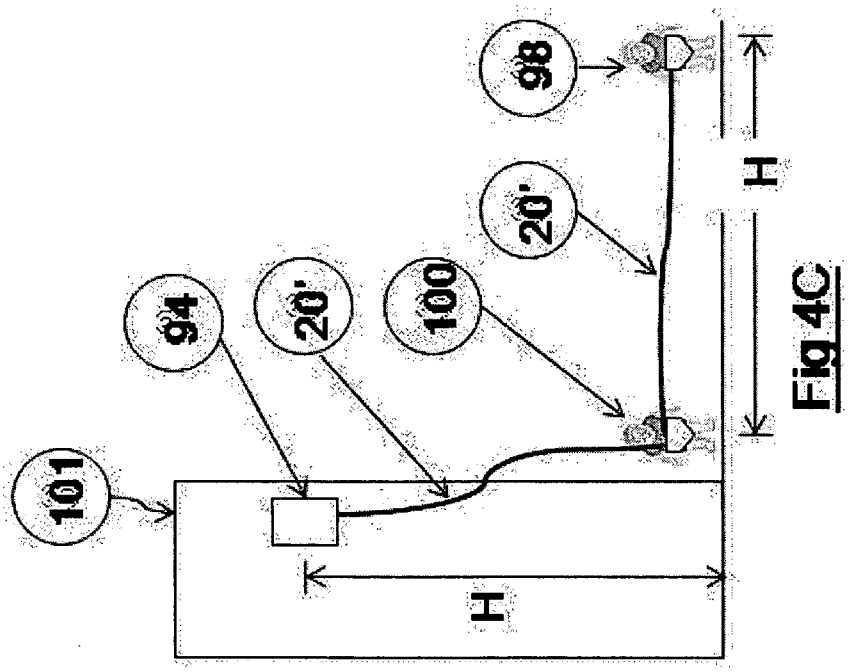


Fig 4C

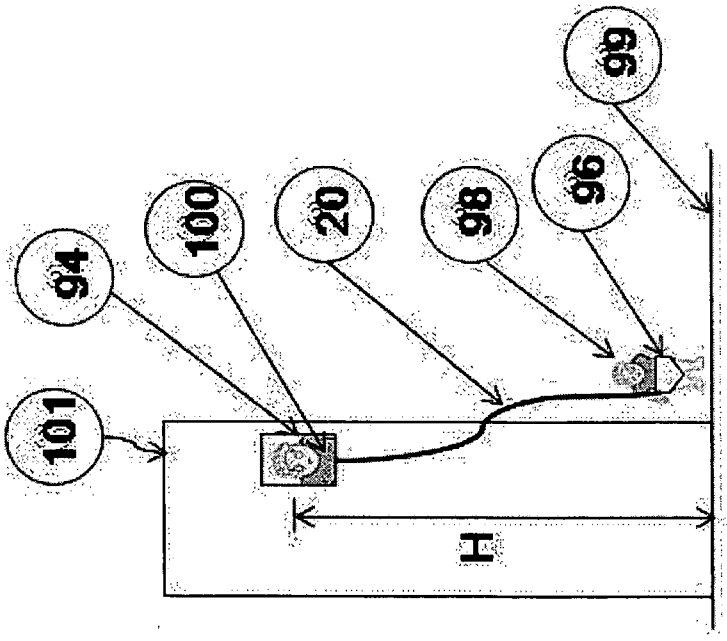


Fig 4B

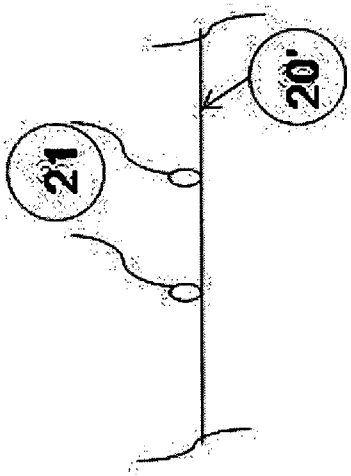


Fig 4D

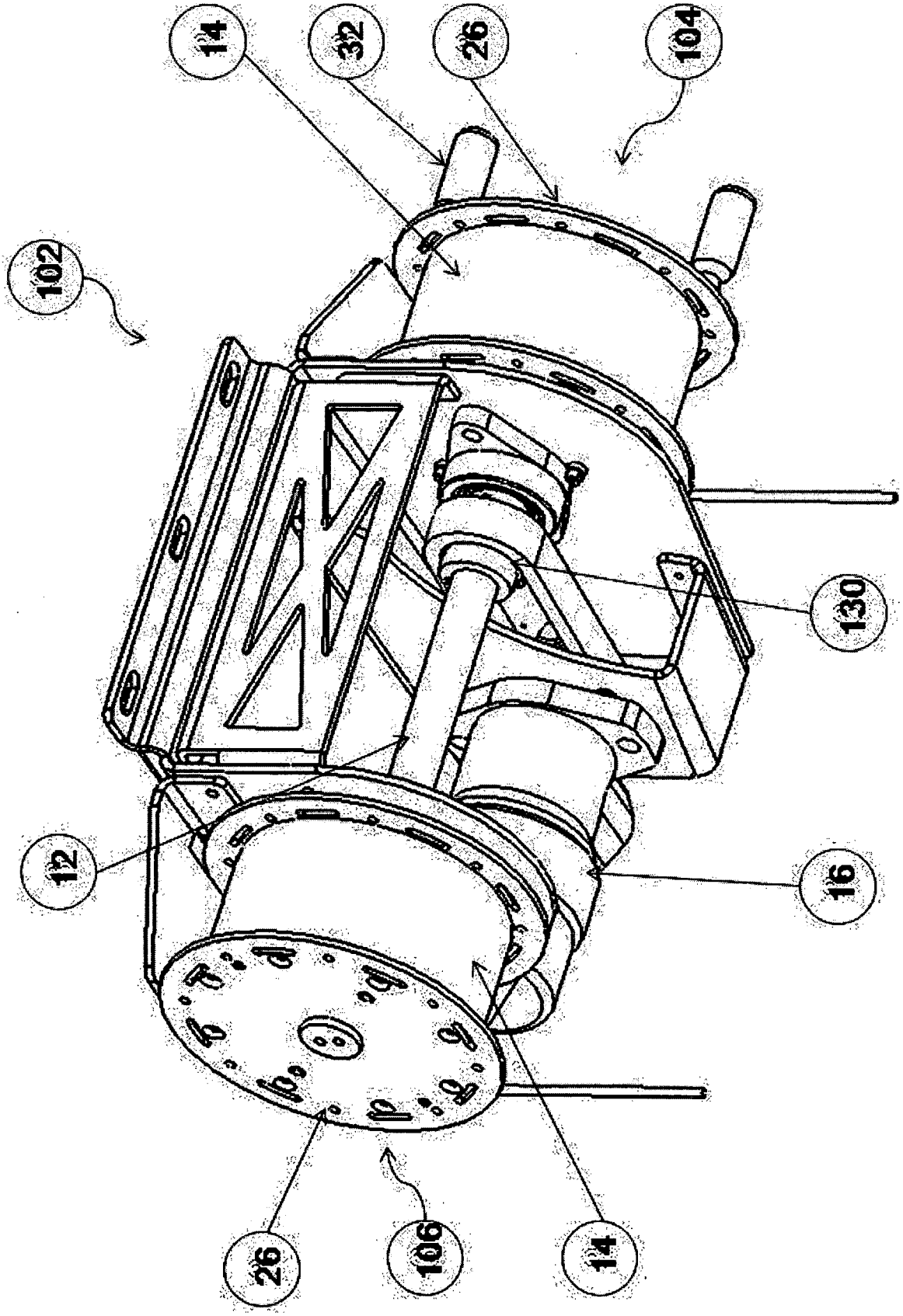


Fig 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 09/00406

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A62B 1/08 (2009.01)
USPC - 182/236
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 182/236
IPC(8): A62B 1/08 (2009.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 182/73,236,238,239,71
IPC(8): A62B 1/08 (2009.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Electronic Databases Searched: Google Scholar; PubWest (US Patents full-text, US PGPubs full-text, EPO Abstracts, and JPO Abstracts) Search Terms Used: lower, lowering, descend, descending, person, persons, people, man, woman, escape, escaping, two, several, many, three, cables, ropes, winches, simultaneous, independent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,442,918 A (RHOADS, SR.) 17 April 1984 (17.04.1984) entire document especially Fig.1A, Fig. 6A, Fig. 7, Fig. 8, abstract, col 5, ln 44-63, col 9, ln 59-68, col 10, ln 1-41, col 10, ln 55-68, col 11, ln 12-21	1-2, 7/1, 7/2, 8/7/1, 8/7/2 --- 3-6, 7/3, 7/4, 7/5, 7/6, 8/7/3, 8/7/4, 8/7/5, 8/7/6, 13-17, 18/15, 18/16, 19-20
Y	US 4,941,549 A (DA-TAN et al.) 17 July 1990 (17.07.1990) Fig. 1, Fig. 5, Fig. 7, Fig. 8, col 2, ln 18-27, col 3, ln 1-30, col 3, ln 59-63, col 4, ln 15-24, col 10, ln 28-41	3-4, 7/3, 7/4, 8/7/3, 8/7/4, 13-14, 16-17, 18/16, 20
Y	US 4,327,818 A (TEPSA et al.) 04 May 1982 (04.05.1982) Fig 1, Fig. 2, col 1, ln 37-53, col 2, ln 13-17	5-6, 7/5, 7/6, 8/7/5, 8/7/6, 15, 18/15, 19
A	US 4,287,963 A (COXSEY) 08 September 1981 (08.09.1981) entire document generally	1-8, 13-20
A	US 4,520,900 A (ORGERON) 04 June 1985 (04.06.1985) entire document generally	1-8, 13-20
A	US 6,808,047 B2 (TAKESHIMA) 26 October 2004 (26.10.2004) entire document generally	1-8, 13-20
A	US 6,868,942 B2 (BARZILAI et al.) 22 March 2005 (22.03.2005) entire document generally	1-8, 13-20

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 July 2009 (23.07.2009)	06 AUG 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 09/00406

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 9-12 (originally numbered 8-11)
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.