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(54) **IMPROVED FALL-ARREST SYSTEM FOR PERSONS WORKING AT HEIGHT**

VERBESSERTES ABSTURZSICHERUNGSSYSTEM FÜR PERSONEN, DIE IN HÖHE ARBEITEN

DISPOSITIF ANTI-CHUTE AMELIORE POUR DES PERSONNES TRAVAILLANT EN HAUTEUR

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Description

[0001] The present invention relates to an improved fall-arrest system for persons working at height, for example on a high building or structures where there is a risk of serious injury or death should the person trip or fall.

[0002] It is known to provide fall-arrest systems (FAS) designed to arrest the falls of workers should they fall whilst working at height. Such systems comprise a safety track held by track supports in spaced relation to a structure, and a coupling component for connecting a worker's safety harness to the said track via a safety line, said component being coupled to said track but being freely displaceable therealong.

[0003] The safety track of a system can most suitably be a rigid rail or a flexible cable or rope, which is slid or threaded through track-receiving eyes or sleeves provided on the track supports. Such supports and the coupling component can be formed so that displacement of the coupling component along the track is not obstructed by the supports.

[0004] Such systems serve to protect workers in situations where they would otherwise be exposed to risk of serious injury or death by falling. For example, they can be used for protecting workers whilst climbing structures such as towers and masts, or on walkways running along the exteriors of structures, high above the ground, or on walkways above open vats or other containers holding harmful liquids. Should a fall occur, the resulting gravitational plummet of the worker is automatically retarded and arrested by the system by applying an arresting force, so that the worker is stopped completely before hitting the ground, other prominent and substantive platform or dangerous substance. Shock absorbing means may be incorporated into such systems for avoiding such abrupt arrest of a fall as could itself cause serious injury, and to comply with performance specifications, which limit the force to which a human body is subjected in the event of a fall-arrest.

[0005] A number of these track-based FAS have been made available in the course of time for a variety of industrial applications. They can be classified into two main groups: the permanently installed type and the temporarily installed type. With the permanent FAS, the main part is permanently attached to the structure requiring access and therefore is dedicated to that structure. In effect this type is "pre-installed", so that any worker arriving on site has an immediate means of protection available without the need to carry out any further action. In addition, these systems are installed in such a manner to run, and therefore provide protection, over the full course of the intended access route, which in turn provides a great range of movement for the worker. A worker can therefore move along the whole access route and back again with relative impunity.

[0006] In contrast, the temporary type are designed to be temporarily installed on a variety of structures, and therefore have to be reasonably portable in order to accompany the worker when travelling from site to site. This type of FAS has to be attached to the structure in such a manner to accommodate the access route and working area before it can provide protection, and has to be removed after completion of the work.

[0007] The first task therefore is to gain access in order to attach the temporary FAS, which cannot provide protection during this activity, so an additional, secondary FAS has to be utilised whilst the installation work is undertaken.

[0008] Whilst this secondary FAS provides protection, the technique that has to be adopted in order to utilise it impedes movement, causes worker fatigue, and slows the whole work process down. Once the temporary FAS is installed, the work task can then be performed.

[0009] The range of worker movement provided by these temporarily installed FAS is limited by the size or length of the equipment, (due to the need for portability). To go beyond this requires the FAS to be reinstalled in a new position to give a new range of movement.

[0010] After completion of the work, the final task is to remove the temporary FAS. Again, protection cannot be provided by the temporary FAS during this activity, so recourse to a secondary FAS is made again, whilst the temporary FAS is removed.

[0011] Whilst the invention relates predominantly to a FAS of the permanently installed type, it is in no way limited to that particular type and can be easy applied to the temporary type. However in recognising the greater number of drawbacks associated with temporary types as outlined above, the preferred embodiment relates to the permanently installed type.

[0012] A number of the permanent type of FAS have been made available in the course of time for a variety of industrial applications. In order to provide the advantages described over the temporary type, and therefore to facilitate ergonomics, commensurate with providing protection, it is vital that such systems are installed adjacent to the intended access route or path that a worker would take in order to complete the work task. This has led to the design of such FAS solely for movement in the vertical direction, needed for example in ladder climbing up masts and towers, and solely in the horizontal direction, needed for example to clean a row of windows on the exterior of an office block.

[0013] Vertical rail (VR) based FAS and vertical lifeline (VLL) based FAS are the main permanently installed types which provide protection against falls from a height whilst moving solely in the vertical direction.

[0014] The VR type consists of a rigid track or rail and a sliding device. The track is typically mounted in the centre of a permanently installed vertical ladder. It is supported at intervals by intermediate brackets, which can be attached to the ladder rungs or stiles, and runs the entire length of the intended vertical ascent. The sliding device is designed to slide up and down the rail, and has a sprung-loaded locking mechanism with an attachment point for a short safety line, which in turn is connected to

a frontal attachment point on a worker's safety harness. This allows the sliding device, once positively engaged onto the rail, to slide up and down in response to the worker's ascending and descending movements, but will lock onto the rail in response to the sudden jerk of a fall.

[0015] The VLL type consists of a cable and a sliding device. Like the VR, the cable is also typically mounted in the centre of a permanently installed vertical ladder. It also is installed along the entire length of the intended ascent, but being flexible, is tensioned between an upper and lower anchor, which are at the cable ends. It is retained at intervals by intermediate brackets, which can be attached to the ladder rungs or stiles. The sliding device is identical in purpose and operation to that of the VR, except in regard to the intermediate brackets.

[0016] With the VR, the brackets attach the rear of the rail to the ladder, and the front of the rail faces the climber. This means that the sliding device can slide past the brackets without the device interfering with the brackets. With the VLL, by their very nature the intermediate brackets have to totally or partially encircle the lifeline since it cannot be held or guided in any other way. This creates a problem for the sliding device in that it cannot physically pass these points during the climb, and therefore requires a feature which will allow the device to pass over the bracket, but which does not allow the disengagement of the device at any time. This feature has to be so designed to be capable of passing over successive brackets consistently, without restricting the natural movement of the worker.

[0017] The locking mechanism of the VR or VLL sliding device is typically sprung-loaded towards the locked-on position, for safety reasons. This means that should a fall occur, the device automatically locks onto the rail or lifeline under the action of the spring. It also means that the device cannot slide up or down the VR or VLL unless the locking mechanism is held away from the rail or lifeline, by a force greater than that of the spring.

[0018] Before ascending a typical structure, the worker, having donned a safety harness, connects the safety line of the VR or VLL sliding device to a frontal attachment point on the harness, hereafter referred to as the harness attachment point (HAP). In the ascent, the climbing action of the worker produces a tension in the safety line, which holds the device's locking mechanism away from the rail or lifeline, and simultaneously allows the device to be pulled up the rail or lifeline. As a result, the HAP remains above the device, i.e. the worker's HAP precedes it. The lead between the HAP and device is dependant on the length of the safety line.

[0019] In the descent, the tension in the safety line caused by the weight of the device serves to hold the locking mechanism away from the rail or lifeline, and simultaneously allows the device to slide down the rail or lifeline. Again the HAP remains above the device, but in the descent the device precedes the HAP.

[0020] This relative positioning of the HAP and the sliding device in both the ascent and descent is such that the sliding device runs up or down the rail or lifeline at a position roughly level with the waist on the climber's body. Given that the sliding device has a certain depth, this means that the climber's body has to arch away from the device during climbing movements to allow the device to slide.

[0021] Furthermore, if the tension in the safety line diminishes to a level lower than that of the locking-on action of the spring, the spring will force the locking mechanism into contact with the rail or lifeline. This causes the sliding device to momentarily stick onto the rail/lifeline, which causes a nuisance to the climber, particularly in the descent. This sticking can arise during momentary climbing movements, when the climber's body moves towards the rail or lifeline, releasing the tension in the safety line. This often results in the climber having to adopt a precautionary leaning-back posture to accommodate potential sticking.

[0022] Consequently the depth of the sliding device, it's sliding position relative to the body, and its potential for sticking on the rail or lifeline during climbing movements, results in the climber having to adopt an arching away and leaning back posture which is not very desirable in terms of climbing ergonomics.

[0023] If a fall occurs, the tension in the safety line is released momentarily in response to the rapid downward motion of the worker and *ipso facto* the worker's HAP also. The locking action of the sliding device is immediately activated by the spring, causing a locking engagement with the rail or lifeline, retarding any downward motion of the device and bringing it to a complete stop in a very short distance. This in effect creates a fixed anchor point on the rail/lifeline to resist the subsequent downward tug of the arresting impact. This impact occurs when the worker has fallen through such a distance whereupon the slack in the safety line is taken up and the rapid rise in tension provides the arresting means to stop the worker. Taking the HAP as a datum point, the worker freefalls[1] a distance of approximately twice the safety line length from the onset of the fall to the onset of arrest, because the HAP is above the device at the onset of the fall, and is below the device at the onset of arrest.

[1] the distance or time whereupon no forces act on the worker except gravitation and air resistance

[0024] The process of free falling through twice the length of the safety line before the arrest takes place creates a number of adverse factors in terms of fall-arrest performance. During the period of freefall, the falling worker generates an amount of energy, which has to be dissipated or "absorbed" by the FAS. The greater the freefall, the greater the amount of energy to be absorbed is, and therefore the greater the energy absorbing capacity required.

[0025] This fall generated energy is absorbed by the application of the arresting (or braking) force, over a distance, (the arrest or braking distance), at the end of which the worker is completely brought to a halt. The energy can either be absorbed quickly — by applying a high ar-

rest force over a relatively short arrest distance, or can be absorbed at a slower rate — by applying a lower arrest force over a longer arrest distance.

[0026] In the case of the VR and VLL type FAS the past design philosophy has typically been to chose the quick arrest characteristic. Whilst this means that the worker experiences high arrest forces at almost the upper limit, the aim has been to keep the arrest distance relatively short. This is necessary in order to minimise the inevitable lateral impacts between a worker and the ladder during an arrest. However, the application of a high arrest force is far from ideal, but it is necessary in order to absorb the energy generated from a freefall equivalent to twice the length of the safety line, whilst at the same time minimising arrest distance.

[0027] In theory one could attempt to lower the arrest force by reducing the amount of energy generated during freefall, by shortening the safety line. However this is not a practical solution, because the smooth operation of the sliding device and good climbing ergonomics requires a minimum length of safety line. Another idea, which has received considerable reception, is to incorporate an energy absorbing mechanism within the safety line. Whilst this can lower the arrest forces to more desirable levels, it adds a cost to the fall arrest device, it makes it heavier, it makes climbing more difficult, and the absorption method increases arrest distance, which is counter-productive to the need to keep arrest distances short.

[0028] In conflict with these ideas is the ergonomic desire to have a relatively long safety line. Whilst VR and VLL based FAS provide an excellent range of movement for the worker in the vertical plane, the extent to which a worker can move in the horizontal plane is severely limited by the length of the safety line. Horizontal movement is also limited in order to avoid the dangers of swing or pendulum falls, which if they occur, can result in a loss of arresting performance and/or an injurious swinging impact to the worker.

[0029] Horizontal rail (HR) and horizontal lifeline (HLL) based FAS are the main permanently installed types that provide protection against falls from a height whilst moving solely in the horizontal direction.

[0030] Being similar to the VR type, the HR type consists of a rail or track and a sliding device. The rail is typically installed adjacent to a horizontal walkway. It is supported at intervals by intermediate brackets, and runs the entire range of the intended horizontal movement. The sliding device is designed to slide along the rail in both directions, and has a point for the attachment of a safety line, which in turn is typically connected to a dorsal HAP of a worker's safety harness. This allows the sliding device, once positively engaged onto the rail, to slide along the rail in response to worker movement. The HR sliding device does not need a locking mechanism to lock it onto the rail in response to a fall, as with the VR, since the downwards pull of the fall is perpendicular to the rail as opposed to parallel to the rail as with the VR. The rail itself provides the anchoring resistance to the downward pull.

[0031] The HLL type consists of a cable and a sliding device. Like the HR, the cable is also typically installed adjacent to a horizontal walkway. It is also installed along the entire length of the intended horizontal movement, but being flexible, is tensioned between two end anchors, which are at the cable extremities. It is supported at intervals by intermediate brackets. The sliding device is identical in operation to that of the HR, except in regard to the intermediate brackets. With the HR, the brackets attach the rear of the rail to the host structure, and the front of the rail faces the worker. This means that the sliding device can slide past the brackets without the device interfering with the brackets. With HLL, by their very nature the intermediate brackets have to totally or partially encircle the lifeline since it cannot be held or guided in any other way. This creates a problem for the sliding device in that it cannot physically pass through these points, and therefore requires a feature which will allow the device to pass through the bracket, but which does not allow the disengagement of the device at any time. This feature has to be so designed to be capable of passing through successive brackets consistently, without restricting the natural movement of the worker.

[0032] The function of the HR/HLL sliding device is much simpler than that of the VR/VLL counterpart. Before traversing the walkway, the worker, having donned a safety harness, connects one end of the safety line to the device and the other end to the dorsal HAP on the harness. The movement of the worker produces a tension in the safety line that pulls the device along the HR/HLL, in effect trailing behind the worker.

[0033] The large freefall problem as described with the VR/VLL method of operation is not so applicable to the HR/HLL, because the rail or lifeline can be mounted above the worker, or in such a way that the HAP is near the level of the rail or lifeline. Also, since there is no locking mechanism on the sliding device, there is no time lag due to the operation of such a mechanism in a fall situation.

[0034] Historically, both the VR/VLL and HR/HLL types of FAS have afforded protection, providing that in each case access was only required in a single plane, i.e. for solely vertical movement or solely horizontal movement. However situations arose when workers had access routes that required movement in both the vertical and horizontal planes, with having to switch to and from planes perhaps several times during the work.

[0035] The initial response from the providers of FAS has been to offer two different types of system, i.e. a vertical FAS and a horizontal FAS, and to install them adjacently.

[0036] This allows a worker to climb up the vertical FAS, disconnect from that system, and then reconnect to the horizontal FAS, and so on. This is not very satisfactory, since each system requires a different sliding device — the vertical part requiring a sliding device with a locking mechanism and the horizontal part requiring a

sliding device without a locking mechanism - i.e. it has to slide without hindrance in the horizontal plane. Furthermore, as previously discussed, for the vertical part, the safety line connecting the sliding device and the safety harness has to be kept relatively short, for ergonomic and fall arrest performance reasons. This length is often found to be too short for work on the horizontal part, where a greater range of movement away from the track is generally needed. So a worker would need two different sliding devices and two different safety lines for this approach to work, which is very unsatisfactory.

[0037] In order to overcome this, some attempts have been made to integrate a vertical and horizontal FAS. These attempts allow vertically installed rail sections to intersect with horizontally installed rail sections at strategically placed turntable devices. An example of such a device is shown in GB 2 278 627. These devices allow the sliding device to be transferred from the vertical to the horizontal plane, and vice versa, without disconnection having to occur.

[0038] Whilst such systems are an improvement over separate systems, the approach has a limited application. As mentioned previously, each plane requires a different set of properties and functions from the sliding device and its safety line, in order to facilitate good ergonomics in both planes, commensurate with providing a satisfactory range of movement and safe arrest performance. This integrated VR-HR approach does not address the fact that the locking function of the sliding device required in the vertical plane interferes with its sliding function in the horizontal plane. It also does not address the requirement for different lengths of safety line in the vertical and horizontal planes. The only way this problem could be overcome was to give personnel extra safety lines which they could use when in the horizontal plane, but were expressly forbidden to use when in the vertical plane, because of the safety implications.

[0039] This unsatisfactory compromise is further complicated where safe access to an inclined plane is required. Many structures not only have access routes in the vertical and horizontal planes, but also on the incline, especially on rooftops. Some of the inclines are constant, e.g.: as per a sloping roof, but some are curved, e.g.: as per a barrel roof. In the latter example the tangential angle of inclination at the bottom of the roof can be quite steep, whereas at the top it can be almost horizontal.

[0040] While some vertical FAS can perform satisfactorily, providing that the slope is not more than say 30° away from the vertical, any more than this can cause jamming problems with the sliding device, since the locking mechanism interferes with the rail/lifeline when climbing normally. Also the relatively short length of safety line means that a worker would have to move on all fours, when in fact a more erect posture is required.

[0041] Horizontal FAS were also evaluated on the inclined plane, the main drawback being that the sliding devices did not have locking mechanisms. Some providers of these types of system took the stance that, providing the angle of inclined surface was relatively shallow, say up to 15°, there would be no need to have a locking device, because the friction imposed on a worker as they slid down a roof of this shallowness in a fall incident would be sufficient to "eventually" stop a fall. Others took the approach of considering steeper angles and decided to incorporate a locking mechanism which would cause the sliding device to lock onto the inclined rail/lifeline, thereby removing any possibility of doubt. However, this feature could only lock in one orientation, i.e. it could lock on one side of an inclined roof, but not the other side, which prevented workers from climbing up a roof and going over the ridge and down the other side.

[0042] In summary there are a number of drawbacks with existing track based FAS, especially where worker access requires movement between the vertical, horizontal and inclined planes. The present invention seeks to overcome the disadvantages of previous FAS which operate in individual planes, whilst at the same time offering a new FAS which allows a worker to move in the vertical, horizontal and inclined planes, or any combination of these, without the need to disconnect at any point in the system, or the need to changeover equipment, commensurate with ergonomic requirements and safe fall arrest performance.

[0043] According to an aspect of the present invention a fall-arrest system for persons working at height on a structure comprises elongate track means, in the form of a rail, rope, cable or the like, securable to the structure so as to lie adjacent to the intended route of a person climbing and/or traversing and/or descending from the structure, a sliding device being coupled to the track means to be freely displaceable therealong, a safety line extending from the sliding device for attachment to a harness attachment point of a safety harness worn by a person, the sliding device incorporating locking means allowing the sliding device to freely slide along the track means during normal movement of a person connected thereto by means of the safety line but automatically locking the sliding device to the track means in the event of a person falling from said structure characterised in that at least a portion of the safety line is rigid or substantially rigid such that, when the portion of the track means on which the sliding device is positioned is orientated in a vertical or inclined direction, the sliding device is supported on the harness attachment point via the substantially rigid portion of the safety line, maintaining the sliding device above the harness attachment point minimising the distance through which a person might free fall before the locking mechanism is actuated in the event of a fall. By means of the substantially rigid portion of the safety line the sliding device is automatically urged up the track means ahead of the harness attachment point as a person wearing the safety harness ascends the structure and automatically descends the track means under the action of gravity as the person descends the structure.

[0044] Preferably said rigid or substantially rigid portion of the safety line comprises a rigid or substantially

rigid tube encasing the safety line. The tube may be of fixed length or may be telescopically extendible and retractable to adjust the length of said substantially rigid portion of the safety line. The phrase "rigid or substantially rigid" in relation to the safety line is taken to mean having sufficient rigidity to enable the sliding device to be pushed up the track means by a force applied to the safety line via the harness attachment point as the person ascends the structure.

[0045] Preferably the locking means locks the sliding device to the track means in response to a pulling force applied to the sliding device via the safety line when said force has a component parallel to the track means in a direction away from the sliding device. Preferably the locking means comprises a locking lever pivotally mounted within a housing of the sliding device for rotation about an axis, such rotation being resisted by spring action which urges the locking lever towards a neutral position wherein the locking lever extends perpendicular to the track means, the distal end of the locking lever furthest from the track means being connected to the safety line, the opposite end of the locking lever comprising a locking pawl, which may be lined with a braking material, pivotal movement of the locking lever in either direction away from said neutral position, in response to a force applied to said opposite end of the locking lever, via the safety line, in a direction parallel to the track means and away from the sliding device bringing said locking pawl into contact with the surface of the track means. Stop means may be provided preventing the locking pawl from engaging the surface of the track means when a force is applied to the locking lever, via the safety line, in a direction parallel to the track means and towards the locking device, preventing the locking device from being actuated when a pushing force is applied to the sliding device via the safety line.

[0046] The safety line encased by the substantially rigid tube may be extensible by being wound on a spring loaded reel within the body of the sliding device such that it is automatically extendible and retractable and may incorporate a further locking means to lock the reel if the speed of the reel exceeds a predetermined limit in the event of a fall. This would enable the safety line to automatically adopt a fixed, relatively short, length when the sliding device is travelling on a vertical or steeply inclined section of the track means wherein the sliding device is maintained above the harness attachment point, by virtue of the substantially rigid tube, but would become automatically extendible to provide a variable length when the sliding device is travelling on a horizontal or gently inclined section of the track means. Such use of a variable length safety line on vertical or steeply inclined sections of a track has not been possible in prior art systems wherein a sliding device trails and remains below the harness attachment point.

[0047] The track means may comprise a substantially rigid rail having outwardly extending flange portions, the sliding device including wheels engaging the rear faces of said flange portions, allowing it the sliding device to slide along the rail but preventing the sliding from being pulled off the rail in a direction transverse to the rail surface. Preferably the rail has a hollow section defining a channel running along the length of the rail in which heating means can be provided to prevent ice from forming on the rail which would otherwise prevent free passage of the sliding device. The heating means may comprise a flow of heated liquid passing through the channel or may comprise an electrical heating means. Where a guard rail is provided adjacent to the intended route of a person climbing and/or traversing and/or descending from the structure, the track means may be formed integrally with the guard rail.

[0048] In the fall arrest system according to the first aspect of the invention, the relative positioning of the harness attachment point and sliding device is such that free fall is negligible and consequently the degree of fall-generated energy is relatively small as compared with earlier designs. As a result the worker can be arrested at a lower arrest force and in a shorter overall distance, because the free fall has been virtually eliminated. This greatly reduces the possibility of secondary injuries, caused by lateral impacts between the worker and ladder during an arrest. The worker will also avoid any injurious impact with the sliding device itself, since it will be above the trajectory of the fall, unlike previous designs, where an impact between the upper part of the body and device was very likely.

[0049] According to a further aspect of the invention a fall-arrest system for persons working at height on a structure comprises elongate track means, such as a rail, rope, cable or the like, securable to the structure so as to lie adjacent to the intended route of a person climbing and/or traversing and/or descending from the structure, a sliding device being coupled to the track means to be freely displaceable therealong, a safety line extending from the sliding device for attachment to a harness attachment point of a safety harness worn by a person, the sliding device incorporating locking means allowing the sliding device to freely slide along the track means during normal movement of a person connected thereto by means of the safety line but automatically locking the sliding device to the track means in the event of a person falling from said structure characterised in that the locking means is capable of locking movement of the sliding device on the track means, for example in response to a force applied via the safety line in the event of a fall of a person connected thereto, irrespective of the orientation of the portion of the track means upon which the sliding device is positioned.

[0050] Preferably the locking means comprises a locking lever pivotally mounted within a housing of the sliding device for rotation about an axis, such rotation being resisted by spring action which urges the locking lever towards a neutral position wherein the locking lever extends perpendicular to the track means, the distal end of the locking lever furthest from the track means being con-

nected to the safety line, the opposite end of the locking lever comprising a locking pawl, which may be lined with a braking material, pivotal movement of the locking lever in either direction away from said neutral position, in response to a force applied to said opposite end of the locking lever, via the safety line, in a direction parallel to the track means and away from the sliding device bringing said locking pawl into contact with the surface of the track means. Stop means may be provided preventing the locking pawl from engaging the surface of the track means when a force is applied to the locking lever, via the safety line, in a direction parallel to the track means and towards the locking device, preventing the locking device from being actuated when a pushing force is applied to the sliding device via the safety line.

[0051] According to a further aspect of the invention there is provided a safety harness to be worn by a person to protect the person in the case of a fall from a height, the safety harness comprising strap means for extending over a portion of a person's body to retain a person within the safety harness, an extension strap extending from a rear portion of the harness, which portion is, in use, adjacent the back of the wearer, attachment means being provided adjacent to or at a distal end of the extension strap for connection to a safety line or lanyard, connection means being provided on a front portion of the safety harness, which portion is, in use, adjacent the chest of the wearer, the attachment means of the extension strap being releasably connectable to the connection means, such that, when the attachment means is connected to the connection means, the attachment means provides a front harness attachment point for a safety line and, when the attachment means is not connected to the connection means, the attachment means provides a dorsal harness attachment point for the safety line by virtue of the extension line, the arrangement enabling the harness attachment point to be moved from the front to the dorsal positions, and vice versa, without requiring the disconnection of the safety line from the attachment means and providing an extension to the safety line when connected to the dorsal harness attachment point by virtue of the extension line.

[0052] Preferably, when the attachment means of the extension line is connected to the connection means on the front of the harness, the extension line passes over a shoulder of the wearer.

[0053] According to a further aspect of the invention there is provided a track assembly for a fall-arrest system for persons working at height on a structure, said track assembly including a first track section inclined at a first angle and a second track section inclined at a second angle, the second angle being different from the first angle, and a changeover device, the changeover device allowing a sliding device slidably mounted on the track to pass from the first track section to the second track section without being released from the track assembly, said changeover device comprising a tiltable section of track being pivotably mounted for movement between a first position wherein said tiltable section is aligned with and forms a continuation of the first track section and a second position wherein said section of track is aligned with and forms a continuation of the second track section, first and second locking means being provided for locking the tiltable section respectively in its first and second positions, a first and second retaining means being provided adjacent opposed ends of the tiltable section, said first and second retaining means being independently movable between an inoperative position wherein a slidable device can move past the respective retaining means in order to pass onto or pass off the tiltable section and an operative position wherein a slidable device is prevented from moving past the respective retaining means.

[0054] According to a further aspect of the invention there is provided a folding guard rail for securing to a structure adjacent to the intended route of a person climbing and/or traversing and/or descending from the structure, said guard rail comprising pivot means allowing the guard rail to be movable between a raised operative position, wherein the guard rail extends substantially perpendicularly from the surface of said structure, and a folded position wherein the guard rail lies substantially parallel to the surface of said structure, locking means being provided for locking the guard rail in either its operative or folded position.

[0055] Preferably said locking means comprises a catch associated with said pivot means.

[0056] The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a building showing a typical installed layout of a FAS according to the present invention;

Figure 2 is a plan view of the same installed layout as shown in Fig 1;

Figure 3 is a schematic view of a pylon used for the support of electrical transmission cables, showing a typical installed layout of a FAS according to the present invention;

Figure 4 is a perspective view of a worker climbing an installed ladder in a typical elevated situation whilst using the FAS according to the present invention, i.e. in the vertical plane;

Figure 5 is a perspective view of two workers simultaneously using the FAS according to the present invention in the horizontal plane;

Figure 6 is a partial perspective view of a worker using the FAS according to the present invention whilst ascending an inclined plane with a trailing sliding device;

Figures 7a and 7b are respectively a front and sectional view of one embodiment of the sliding device on a track;

Figures 8a and 8b show sectioned schematic views of the sliding device on a track in the vertical plane showing operation of the locking device;

Figure 9 shows a sectioned schematic view of the sliding device on a track in the inclined plane;

Figure 10 shows a sectioned schematic view of the sliding device on a track in the horizontal plane;

Figures 11a, 11 band 11 c shows partial schematic views describing the method of changing HAP position from frontal to dorsal positions when changing from one plane of movement to the other,

Figures 12a, 12b, 13a and 13b are sectioned schematic views showing the sequence of events which permit the sliding device to move through an abrupt change of direction, e.g. over the ridge of a roof, by utilising the tilting changeover device;

Fig 14 is a partial perspective view of a worker using the FAS according to the present invention whilst ascending an inclined plane with an advancing sliding device.

[0057] Figs 1 and 2 illustrate schematically an embodiment of a FAS according to the invention when installed on a building. The FAS describes a continuous safety track which runs alongside a worker's typical climbing route and walkway. It consists of vertical track parts 1 installed on ladders 2, inclined track parts 3 installed on pitched rooftops 4, and horizontal track parts 5, installed in the valleys of the pitched roofs and on a flat roof 6. The track is held closely spaced from the structure by supports 7 which are attached by bolts to the structure.

[0058] A sliding device (not shown in Figs 1 or 2) is engaged onto the track to be freely displaceable thereon during normal movement of a worker attached to the sliding device by means of a safety line, the sliding device having a locking mechanism a portion of which engages the track to lock the sliding device onto the track in the event of a fall by the worker.

[0059] The safety track is so installed as to allow changes in direction of the sliding device when engaged on the track, by utilising turntable devices 8, tilting changeover mechanisms 9, or bends 10. End stops 11 prevent the inadvertent disengagement of the sliding device from the ends of the track.

[0060] The inclined parts of the safety track have integral steps 12 and guard rails 13 to assist a worker in climbing up or down the inclined surface. The guard rails 13 may be permanently erect, or may be so constructed as to have a hinge mechanism, to allow the guard rail to be pivoted down and stowed flush to the roof surface after use (see Fig 6). When it needs to be erected for future use a catch can be released by the worker and it can be rotated upwards into the erect position.

[0061] Fig 3 illustrates schematically an embodiment of the FAS according to the invention illustrated installed on a pylon for supporting electrical transmission cables. Again, the FAS describes a continuous safety track which runs alongside a worker's typical climbing route and walkway consisting of vertical or near-vertical track parts 1 installed on ladders 2, inclined track parts 3 on the bottom of the outriggers, and horizontal track parts 5 installed across members and outriggers. The track is held closely spaced from the structure by supports which are attached by bolts to the structure.

[0062] The safety track is so installed as to allow changes in direction of the sliding device when engaged on the track, by utilising turntable devices 8 and tilting changeover mechanisms 9. End stops 11 prevent the inadvertent disengagement of the sliding device from the ends of the track.

[0063] The FAS illustrated and fastened onto an installed ladder 2 in the vertical plane in Fig 4 describes the vertical track part 1 of a FAS according to the present invention. This vertical track part could be part of a continuous safety track which runs alongside a worker's typical climbing route and walkway, consisting of any number and combination of track parts in the vertical, horizontal and inclined planes, or could itself be the entire safety track. It consists of the track part which is held closely spaced from the ladder by supports 7 which are attached to the ladder rungs.

[0064] The worker is wearing a safety harness 14, which is connected at a frontal harness attachment point (HAP) 15 to the safety line 16 of the sliding device 17. The detail of the worker's right arm has been removed to show the detail of the HAP 15 and safety line 16 attached thereto. The safety line 16 is of fixed length whilst the invention is operated in the vertical plane, which causes the sliding device 17 to be pushed up the safety track 1, ensuring that the HAP 15 always remains below the sliding device 17.

[0065] The FAS illustrated and fastened onto the structure in the horizontal plane in Fig 5 describes the horizontal track part 5 of a FAS according to the present invention. The horizontal track part 5 could be part of a continuous safety track which runs alongside a worker's typical climbing route and walkway, consisting of any number and combination of track parts in the vertical, horizontal and inclined planes, or could itself be the entire safety track. It consists of the track 5 that is held closely spaced to the structure by supports (not shown) which are bolted to the structure.

[0066] The workers are wearing safety harnesses 14 which are connected at a dorsal HAP 18 to the safety line 16 of the sliding device 17. The safety line 16 is extendable and retractable whilst the invention is operated in the horizontal plane, up to a maximum determined by

the storage capacity of a reel within the sliding device 17. The retractable nature of the safety line 16 ensures that irrespective of the worker's position, the safety line 16 maintains the shortest possible length between the HAP 18 and the sliding device 17, which minimises free fall in an accident.

[0067] The design features of the sliding device 17 enable it to be pulled along the track in response to worker movement so that the sliding device 17 trails behind the worker.

[0068] The FAS illustrated and fastened onto the roof structure in the inclined plane in Fig 6 describes the inclined track part 3 of a FAS according to the present invention. The inclined track part 3 could be part of a continuous safety track which runs alongside a worker's typical climbing route and walkway, consisting of any number and combination of track parts in the vertical, horizontal and inclined planes, or could itself be the entire safety track. It consists of the track 3 which is held closely spaced to the structure by supports (not shown) which are bolted to the structure.

[0069] The worker is wearing a safety harness 14 which is connected at a dorsal HAP 18 to the safety line 16 of the sliding device 17. The steps 12 and guard rail 13 may be integral to the track 3 in order to assist a worker in climbing up and down the inclined surface. The guard rail 13 may be permanently erected or may be so constructed as to have a hinge and catch mechanism to allow the guard rail to be pivoted down as indicated by the broken lines and stowed flush to the roof surface after use. When required for future use the hinge and catch mechanism can be operated and the guard rail 13 can be pivoted upwards as indicated by the broken lines and locked into the erect position.

[0070] The safety line 16 is extendable and retractable whilst the FAS is operated in the inclined plane, up to a maximum determined by the storage capacity of the reel within the sliding device. The retractable nature of the safety line 16 ensures that irrespective of the worker's position, the safety line 16 maintains the shortest possible length between HAP 18 and the sliding device 17, which minimises free fall in an accident.

[0071] The design features of the sliding device 17 enable it to be pulled along the track 3 in response to worker movement so that it trails behind the worker. The same features and trailing operation of the sliding device 17 allow the worker to climb over the ridge, and to walk down the opposite surface of the roof.

[0072] Whilst Fig 6 shows the track 3 and integral pivoting guard rail 13 on an inclined surface, it is anticipated by the present invention that such features may also utilised on a horizontal surface.

[0073] Whilst Fig 6 shows the base of guard rail 13 being integral to the track 3, it is anticipated by the present invention that the track 3 may instead be integral to, or may replace either the upper rail or middle rail of the guard rail 13, or may be integral to or be attached to any part of the guard rail 13.

[0074] A rigid rail 1 and sliding device 17 in Figs 7a and 7b shows one example of an embodiment of the present invention. The rail 1 is of a hollow "X" section manufacture which can be joined at pre-determined intervals, and is installed to the host structure by supports 7 and bolts. The channel 20 within the rail can be used to accommodate anti-icing means to prevent the rail from icing up in inclement weather, which otherwise would prevent free passage of the sliding device.

[0075] Wheels 21 are attached to the sliding device by spigots 22 and locate onto the flanges of the rail in such a manner as to prevent the sliding device 17 from disengaging from the rail at any point. The wheels 21 allow the sliding device 17 to be guided along the rail.

[0076] As shown in Figs 8a and 8b, the locking mechanism of the sliding device 17 is in close contact with the rail 1 and locks onto the rail 1 in a fall accident. A variable length safety line 16 is contained on a reel 23, together with a braking mechanism for the safety line 16, within the housing 24 of the sliding device 17. The housing 24 is moveably mounted on the sliding device 17.

[0077] The safety line 16 is encased by a substantially rigid tube 25. The tube 25 ensures that the safety line 16 remains substantially rigid in properties when the track is oriented in the vertical plane, but flexible and automatically extendable and retractable when the track is oriented in the horizontal and inclined planes.

[0078] The sectioned views in Figs 8a and 8b describe the method of working of the sliding device 17 of Figs 7a and 7b whilst in the vertical plane (when operating as shown in Fig 4). The guiding wheels 21 of the sliding device 17 and track detail have been omitted for clarity, except that of the track surface 26 on which the locking mechanism acts. The locking mechanism consists of a locking lever 27 and a gravity switch, which consists of a tube 28, and pellets 29, 29'. The locking lever 27 is pivotally mounted on a pin 30, and can rotate about said pin 30, such rotation being resisted by spring action which urges the locking lever 27 towards the neutral position, i.e. that position when the locking lever is perpendicular to the track surface. The distal end of the locking lever 27 also engages with the safety line housing 24, which is mounted on and can slide in relation to the sliding device 17. The locking lever 27 has a locking pawl 31 which may be lined with a braking material, and has integral pips 32, 32', which are designed to work in concert with the gravity switch.

[0079] The pellets 29, 29' are free to slide up and down the gravity switch tube 28, and are prevented from falling out of the tube by end caps 33. The gravity switch tube 28 has slots to allow the pips 32, 32' to enter said tube 28 as a result of the rotation of the locking lever 27.

[0080] The safety line housing 24 contains a reel 34, braking mechanism 35, and safety line 16. During manufacture, one end of the safety line 16 is secured to the reel 34, and the safety line 16 is then progressively wound onto the reel 34, and exits the housing 24 at an exit bush. The reel 34 is mounted onto an axle (indicted by cen-

treline), allowing it to rotate. It is restrained in one direction by a clock spring (not shown) contained inside the reel 34 and is attached to the housing 24. The effect of this design is to ensure that the safety line 16 is always subjected to a light restraining tension, caused by the action of the clock spring. So as a worker connected to the safety line 16 moves away from the sliding device 17, the safety line 16 is extracted under a light tension, and as the worker comes nearer the sliding device 17, the safety line 16 is automatically retracted. This ensures that the safety line 16 is always the shortest possible distance between the worker and the sliding device 17 without having any slack in the line.

[0081] The braking mechanism 35 is a clutch arrangement mounted on the axle which consists of a fixed brake assembly which is attached to the housing 24, and brake locking pawls (not shown) which are attached to the reel. Both the fixed brake assembly and the brake locking pawls / reel 34 are designed to lock together as one part under fall arrest conditions, but to remain separate under all other conditions. The fixed brake assembly is designed to absorb energy generated from a fall.

[0082] A free-floating pipe 25 which is substantially rigid in properties covers the safety line 16 without restricting the extraction and retraction of safety line 16. The pipe 25 also abuts against the housing 24 and the safety line termination such that a fixed length of safety line 16 is kept permanently outside the housing 24. A connector 36 can be used to connect the safety line 16 to a worker's safety harness.

[0083] Considering Fig 8a, which is the mode of operation of the sliding device 17 during climbing movement in the vertical plane, (as shown in Fig 4), the lower pellet 29' falls to the bottom of the tube 28 under the action of gravity, and the upper pellet 29 similarly falls until it makes contact with locking lever 27. Pushing forces from climbing movements are transmitted up the pipe 25 to the housing 24, which pushes the locking lever 27 upwards about the pin 30. After a certain movement of the locking lever 27, the upper pip 32 abuts the upper pellet 29, which prevents further movement of the locking lever 27, and prevents the locking pawl 31 from making contact with the track surface 26. Whereupon the pushing forces from climbing movement causes the whole sliding device 17 to slide up the track. The position of the locking pawl 31 remains in close proximity with the track surface 26.

[0084] In the descent, the pellets 29, 29'and the locking lever 27 remain in the same position as shown Fig 8a, and the weight of sliding device 17 is transmitted to the pipe 25, allowing the sliding device 17 to slide down the track under the descending action of the worker.

[0085] Fig 8b illustrates the operation of the sliding device 17 should a fall occur. Since virtually no free fall is experienced by the worker, the safety line 16 is extracted immediately at an increasing speed since the worker falls at the acceleration due to gravity. The reel 34 is accordingly imparted rotational acceleration until a pre-determined rotational velocity is achieved whereupon the brake locking pawls engage with the fixed brake assembly, causing the reel 34 to instantly stop rotating. This causes the locking lever 27 to be pulled sharply downwards, causing the locking pawl 31 to interfere with the track surface 26, bringing the sliding device 17 to a complete halt. Any fall-generated energy developed during this period is then absorbed by the fixed brake assembly 35, which resists subsequent downward motion by applying a braking force, and which results in some extraction of the safety line 16, which is exposed as the pipe 25 slides down the safety line 16 from the housing 24.

[0086] In another embodiment of the invention (not shown), where movement is solely required in the vertical plane, the variable length safety line can be replaced with a substantially rigid fixed length safety line, attached to locking lever and to the worker's safety harness.

[0087] The sectioned partial view in Fig 9 describes the method of working of the sliding device 17 whilst in the inclined plane, i.e. when ascending (Fig 6) or descending the same inclined surface, or when ascending and descending the sides of a pitched roof. The guiding wheels of the sliding device and track details have been omitted for clarity, except that of the track surface 26 on which the locking mechanism acts. The description of the sliding device 17 and the variable length safety line 16 is identical to that described under Figs 8a and 8b.

[0088] In the incline, the lower pellet falls 29 to the bottom of the gravity-switch tube 28 under the action of gravity and the upper pellet 29' similarly falls until it makes contact with the locking lever 27. Extraction of the safety line 16 occurs due to the position of the HAP on the safety harness and the height of the worker. The pipe 25 slides away from the safety line 16 termination. Pulling forces due to climbing movements up the incline which when balanced with the safety line reel clock spring are transmitted to the safety line housing 24, which pushes the locking lever 27 up about the pin 30.

[0089] After a certain amount of movement of the locking lever 27, the pip 32' abuts the upper pellet 29', which prevents further movement of the locking lever 27, and prevents the locking pawl 31 from making contact with the track surface 26. Whereupon the pulling forces from climbing movement causes the whole sliding device to slide up the track. The position of the locking pawl 31 remains in close proximity with the track surface 26. In the descent situation the pellets 29, 29' and the locking lever 27 remain in the same position and the weight of sliding device 17 enables it to slide down the track.

[0090] Should the angle of inclination of the inclined surface be inverted, for example when a worker climbs over the ridge of a pitched roof and starts to descend the opposite side, the pellets 29, 29' reverse position under the action of gravity. The upper pellet 29' in Fig 9 falls to the bottom of the gravity-switch tube 28 and similarly the lower pellet 29 falls until it makes contact with the locking lever 27. The operation of the sliding device 17 is then identical to that described above.

[0091] In a fall situation the apparatus reacts in the

same way as described previously when considering Figs 8a and 8b. The worker will fall past the sliding device 17, causing some retraction of the safety line 16 as a result of the reel clock spring winding it in. This will occur until the termination 36 abuts the pipe 25. The variable length safety line 16 will then lock and brake as described previously, causing the locking lever 27 to be pulled sharply downwards, causing the locking pawl 31 to interfere with track surface 26, bringing the sliding device and worker to a complete halt.

[0092] In another embodiment of the invention (not shown), where movement is solely required in the inclined plane, the variable length safety line can be replaced with a fixed length safety line, attached to the locking lever and to the worker's safety harness.

[0093] The sectioned partial view in Fig 10 describes the method of working of the sliding device 17 whilst in the horizontal plane (as shown in Fig 5). The guiding wheels of sliding device and track details have been omitted for clarity, except that of the track surface 26 on which the locking mechanism acts. The description of the sliding device 17 and variable length safety line 16 is identical to that described under Figs 8a and 8b.

[0094] In the horizontal, the position of the pellets 29, 29' is irrelevant since the locking of the sliding device 17 on the track surface is not required. This is due to the fact that any fall arrest force applied will be perpendicular to the track, so that the track on its own provides a reaction to the fall. The locking lever 27 adopts a near neutral position and extraction of the safety line 16 occurs due to the position of the HAP on the safety harness and the height of the worker. The pipe 25 slides away from the safety line housing 24. Pulling forces due to traversing movements in the horizontal which when balanced with the safety line reel clock spring are transmitted to the safety line housing 24.

[0095] The spring bias of the locking lever 27 ensures that it remains in an approximate neutral position which prevents the locking pawl 31 from making contact with the track surface 26. Whereupon the pulling forces from traversing movement causes the whole sliding device 17 to slide along the track.

[0096] In a fall situation the apparatus reacts in a similar way as described previously when considering Figs 8a and 8b. The worker will fall past the sliding device 17, causing some retraction of the safety line 16 as a result of the reel clock spring winding it in. This will occur until the pipe 25 abuts the safety line housing 24. The variable length safety line 16 will then lock and brake as described previously, bringing the worker to a complete halt. The locking mechanism feature is not utilised in this plane.

[0097] In another embodiment of the invention (not shown), where movement is solely required in the horizontal plane, the variable length safety line can be replaced with a fixed length safety line, attached to the locking lever and to the worker's safety harness.

[0098] Figs 11 a, 11b and 11c respectively show three schematic views of the process of changing the HAP position from the frontal 15 to dorsal 18 positions when moving from the vertical plane of movement to the horizontal or inclined planes of movement. In Fig 11 a the worker has ascended to a position where the sliding device 17 previously (indicated by broken line) on a vertical track has been transferred by a turntable 8 onto a horizontal track, where the sliding device is now ready to slide in the horizontal plane. The worker is still facing the track as a result of being connected into the FAS at the frontal HAP 15.

[0099] The HAP changeover feature which is an integral part of the safety harness worn by the worker consists of a safety catch, an extension strap 37, which is stowed with one of the shoulder straps of the safety harness, and is directly attached at the dorsal HAP position 18.

[0100] Considering Fig 11 b, the worker undoes the safety catch, which allows the extension strap 37 to pay out above the shoulder whilst still remaining connected to the safety line 16 at the HAP which is now separated from the front position of the safety harness.

[0101] Considering Fig 11c, the worker now can face away from the track and can proceed to traverse horizontally along horizontal track part. The extension strap 37 remains attached to the safety harness at the dorsal position 18 and to the safety line 16 via the HAP.

[0102] Stowage of the extension strap when a vertical track part is encountered is a reverse procedure of the above.

[0103] If the course of the track is such that an abrupt change in direction is needed, and due to the geometry involved, the change in direction is too severe for a bend in the track, or such a bend would restrict the free passage of the sliding device 17, a tilting changeover device 9 can be utilised. Examples of such situations include transiting from the vertical plane to the inclined plane over the eaves of a roof, and vice versa, transiting upward from one inclined surface of a pitched roof over the ridge to the opposite downwards-facing surface, and negotiating an external corner in the horizontal plane. The sequence of events which allow the sliding device 17 to move through such an abrupt change of direction using the tilting changeover device 9 are shown in Figs 12a, 12b, 13a and 13b.

[0104] In Figs 12a and 12b the tilting changeover device (TCD) 9 is shown mounted to the ridge of a roof by a pivot arrangement. Each view shows a side elevation and a plan elevation underneath. In Fig 12a the sliding device 17 is being pulled up the exiting track 38, i.e. the end of the track run that the sliding device 17 is exiting into the TCD 9. The TCD 9 is held and kept in line with the track by the locking catch 39. The first retaining pin 40 may either be disengaged automatically by the movement of the sliding device 17 as shown, or this may be done manually, to allow the sliding device 17 in. The second retaining pin 41 remains engaged and acts as a stop to prevent the sliding device 17 from leaving the TCD 9.

[0105] In Fig 12b the sliding device 17 has been posi-

tioned fully within the TCD 9 and the first retaining pin 40 may either lock automatically shut under the influence of a spring or may be engaged manually. With both retaining pins 40, 41 fully engaged the sliding device 17 cannot slide out of the TCD 9 during the next sequence which involves the pivoting of the whole assembly.

[0106] In Figs 13a and 13b the TCD 9 arrangement is identical to that shown in Figs 12a and 12b. In Fig 13a the sequence proceeds when the locking catch 39 on the exiting track 38 is disengaged, which allows the TCD 9 and sliding device 17 to be pivoted through the necessary angle, and automatically engages with the locking catch 42 on the recipient track 43 when the TCD 9 is properly aligned. The TCD 9 is held and kept in line with the track 43 by the locking catch 42. Both retaining pins 40, 41 prevent the sliding device 17 from leaving the TCD 9 inadvertently.

[0107] In Fig 13b the second retaining pin 41 is released which allows the sliding device 17 to run into the receiving track 43, and the worker can proceed.

[0108] Whereas in Fig 6 the design features of the sliding device 17 caused said device 17 to trail behind the worker whilst climbing an inclined surface, Fig 14 shows another embodiment of the invention, the features of which allow the sliding device 17 to be pushed ahead in response to worker movement. This approach further reduces the amount a worker could fall in a fall incident, and is similar to the method utilised for the vertical plane. Fig 14 also shows the guard rail 13 features previously mentioned.

[0109] The worker wears the safety harness 14, which is connected at the frontal HAP 15 to the safety line 16 of the sliding device 17. Prior to climbing up the inclined surface, the worker extends the substantially rigid tube 25 that encases the safety line 16, which accordingly extracts the safety line 16 from the housing 24. (This apparatus is also utilised in the vertical plane to ensure that the sliding device 17 is pushed up the track 1 in response to worker movement). This extension is achieved by a telescoping action, which automatically locks when of the correct length, encasing what amounts to a fixed length of safety line 16. Pushing forces from climbing movements are then transmitted up the tube 25 to the housing 24 of the sliding device 17, which causes the locking mechanism to operate as described above in relation to Figs 8a and 8b. A further advantage of this arrangement is that should a worker fall through the inclined surface, e.g. through a fragile surface such as a roof light, the tube 25 provides protection against the shearing action of the safety line 16 on any sharp or abrupt edge.

[0110] Various additional features may be used with or incorporated with the present invention, which are not illustrated, as follows:

[0111] In the vertical plane the track of the FAS may either be mounted to an existing ladder or may be incorporated into a ladder as part of its manufacture. In the latter case this may result in a single or double-stiled ladder, which may have adjustable rung intervals to suit different anthropometric ranges of climbers' dimensions in different countries.

[0112] In the vertical plane, rest platforms may be installed at intervals up the ladder.

[0113] Gate devices may be installed at any point on the track, irrespective of orientation, to allow the sliding device to be attached or detached at those points according to work requirements. Alternatively an opening device may be incorporated within the sliding device itself, to allow it to be attached to or detached from the track at any point.

[0114] Turntables or switches, which enable a worker to transfer the sliding device from plane to plane, or to transfer between near-parallel routes.

Claims

1. A fall-arrest system for persons-working at height on a structure comprising elongate track means (1,3,5), in the form of a rail, rope, cable or the like, securable to the structure (4) so as to lie adjacent to the intended route of a person climbing and/or traversing and/or descending from the structure, a sliding device (17) being coupled to the track means to be freely displaceable therealong, a safety line (16) extending from the sliding device (17) for attachment to a harness attachment point of a safety harness (14) worn by a person, the sliding device (17) incorporating locking means (27,28,29,29',31,32,32') allowing the sliding device to freely slide along the track means during normal movement of a person connected thereto by means of the safety line (16) but automatically locking the sliding device to the track means in the event of a person falling from said structure **characterised in that** at least a portion of the safety line (16) is encased by a rigid or substantially rigid tube or pipe (25), or at least a portion of the safety line is rigid or substantially rigid, such that, when the portion of the track means on which the sliding device (17) is positioned is orientated in a vertical or inclined direction, the sliding device is supported on the harness attachment point (18) via the tube or pipe (25) or substantially rigid portion of the safety line (16), maintaining the sliding device (17) above the harness attachment point (18) and minimising the distance through which a person might free fall before the locking means (27,28,29,29', 31,32,32') is actuated in the event of a fall.

2. A fall-arrest system as claimed in claim 1, wherein the rigid or substantially rigid tube or pipe (25) encasing the safety line (16) is slidable therealong.

3. A fall-arrest system as claimed in claim 1 or 2 wherein the safety line (16) encased by the rigid or substantially rigid tube (25) is extensible by being wound on

a spring loaded reel within the body of the sliding device (17) such that it is automatically extendible and retractable and incorporates a further locking mechanism (25) to lock the reel if the speed of the reel exceeds a predetermined limit in the event of a fall.

4. A fall-arrest system as claimed in any of claims 1 to 3, wherein the tube (25) is of fixed length.

5. A fall-arrest system as claimed in any of claims 1 to 3, wherein the tube (25) is telescopically extendible and retractable to adjust the length of said substantially rigid portion of the safety line.

6. A fall-arrest system as claimed in any preceding claim, wherein the locking means locks the sliding device to the track means in response to a pulling force applied to the sliding device (17) via the safety line (16) when said force has a component parallel to the track means in a direction away from the sliding device.

7. A fall-arrest system as claimed in any preceding claim, wherein, the locking means comprises a locking lever (27) pivotally mounted within a housing (24) of the sliding device for rotation about an axis, such rotation being resisted by spring action which urges the locking lever (27) towards a neutral position wherein the locking lever extends perpendicular to the track means, the distal end of the locking lever furthest from the track means being connected to the safety line (16), the opposite end of the locking lever comprising a locking pawl (31), pivotal movement of the locking lever in either direction away from said neutral position, in response to a force applied to said opposite end of the locking lever, via the safety line, in a direction parallel to the track means and away from the sliding device bringing said locking pawl into contact with the surface of the track means.

8. A fall-arrest system as claimed in claim 7, wherein the locking pawl (31) is lined with a braking material.

9. A fall-arrest system as claimed in claim 7 or claim 8, wherein stop means (29,29') are provided preventing the locking pawl (31) from engaging the surface of the track means when a force is applied to the locking lever, via the safety line, in a direction parallel to the track means and towards the locking device, preventing the locking device from being actuated when a pushing force is applied to the sliding device via the safety line.

10. A fall-arrest system as claimed in any preceding claim, wherein the track means (3,13) comprises a substantially rigid rail (1) having outwardly extending flange portions, the sliding device (17) including wheels (2) engaging the rear faces of said flange portions, allowing the sliding device to slide along the rail but preventing the sliding device from being pulled off the rail in a direction transverse to the rail surface.

11. A fall-arrest system as claimed in claim 10, wherein the rail (1) has a hollow section defining a channel (20) running along the length of the rail in which heating means can be provided to prevent ice from forming on the rail which would otherwise prevent free passage of the sliding device (17).

12. A fall-arrest system as claimed in claim 11, wherein the heating means comprises a flow of heated liquid passing through the channel (20) or comprises an electrical heating means.

13. A fall-arrest system as claimed in any preceding claim, wherein a guard rail (13) is provided adjacent to the intended route of a person climbing and/or traversing and/or descending from the structure, the track means (3) may be formed integrally with the guard rail.

14. A fall-arrest system as claimed in any preceding claim in which the locking means is capable of locking movement of the sliding device on the track irrespective of the orientation of the portion of the track means upon which the sliding device is positioned.

15. A fall-arrest system as claimed in any of claims 1 to 14, wherein the locking means (27,28,29,29'31,32,32') locks movement of the sliding device (17) in response to a force applied via the safety line (16) in the event of a fall of a person connected thereto.

16. A fall-arrest system as claimed in any of claims 14 and 15, wherein the locking means (27,28,29,29', 31,32,32') comprises a locking lever (27) pivotally mounted within a housing of the sliding device (17) for rotation about an axis, such rotation being resisted by spring action which urges the locking lever towards a neutral position wherein the locking lever extends perpendicular to the track means, the distal end of the locking lever furthest from the track means being connected to the safety line, the opposite end of the locking lever comprising a locking pawl, pivotal movement of the locking lever in either direction away from said neutral position, in response to a force applied to said opposite end of the locking lever, via the safety line, in a direction parallel to the track means and away from the sliding device bringing said locking pawl into contact with the surface of the track means.

17. A fall-arrest system as claimed in claim 16, wherein

the locking pawl is lined with a braking material.

18. A fall-arrst system as claimed in claim 17 or claim 18, wherein stop means (29,29') are provided preventing the locking pawl (31) from engaging the surface of the track means when a force is applied to the locking lever (27), via the safety line, in a direction parallel to the track means and towards the locking device, preventing the locking means from being actuated when a pushing force is applied to the sliding device via the safety line.

19. A fall-arrest system as claimed in any of claims 1 to 18 also including a safety harness (14) to be worn by a person to protect the person in the case of a fall from a height, the safety harness comprising strap means for extending over a portion of a person's body to retain a person within the safety harness, an extension strap extending from a rear portion of the harness, which portion is, in use, adjacent the back of the wearer, attachment means being provided adjacent to or at a distal end of the extension strap for connection to a safety line or lanyard (16), connection means (15) being provided on a front portion of the safety harness, which portion is, in use, adjacent the chest of the wearer, the attachment means of the extension strap being releasably connectable to the connection means, such that, when the attachment means is connected to the connection means the attachment means provides a front harness attachment point (15) for the safety line and, when the attachment means is not connected to the connection means, the attachment means provides a dorsal harness attachment point for the safety line by virtue of the extension strap, the arrangement enabling the harness attachment point to be moved from the front to the dorsal positions, and vice versa, without requiring the disconnection of the safety line from the attachment means and providing an extension to the safety line when connected to the dorsal harness attachment point by virtue of the extension strap.

20. A fall-arrest system and safety harness as claimed in claim 19, wherein, when the attachment means of the extension strap is connected to the connection means on the front of the harness, the extension line passes over a shoulder of the wearer.

21. A fall-arrest system as claimed in any of claims 1 to 20, also including a track assembly for the fall-arrest system including a first track section (38) inclined at a first angle and a second track section inclined at a second angle, the second angle being different from the first angle, and a changeover device (9), the changeover device allowing a sliding device slidably mounted on the track to pass from the first track section to the second track section without being released from the track assembly, said changeover device (9) comprising a tiltable section of track being pivotably mounted for movement between a first position wherein said tiltable section is aligned with and forms a continuation of the first track section and a second position wherein said section of track is aligned with and forms a continuation of the second track section, first and second locking means (39,42) being provided for locking the tiltable section respectively in its first and second positions, a first and second retaining means being provided adjacent opposed ends of the tiltable section, said first and second retaining means (40,41) being independently movable between an inoperative position wherein a slidable device can move past the respective retaining means in order to pass onto or pass off the tiltable section and an operative position wherein a slidable device (17) is prevented from moving past the respective retaining means.

22. A fall-arrest system as claimed in any of claims 1 to 21, also including folding guard rail (13,Fig.6) for securing to a structure adjacent to the intended route of a person climbing and/or traversing and/or descending from the structure, said guard rail comprising pivot means allowing the guard rail to be movable between a raised operative position, wherein the guard rail extends substantially perpendicularly from the surface of said structure, and a folded position wherein the guard rail lies substantially parallel to the surface of said structure, locking means being provided for locking the guard rail in either its operative or folded position.

23. A fall-arrest system including folding guard rail as claimed in claim 22, wherein said locking means comprises a catch (39) associated with said pivot means.

24. A fall-arrest system as claimed in one or more of claims 1 to 23, in which, in use, the sliding device (17) is supported on the harness attachment point via the rigid or substantially rigid safety line (16) such that the sliding device (17) is maintained above the harness attachment point so as to reduce, relative to a fully flexible safety-line, the distance through which a person might otherwise free fall before the locking means (27,28,29,29',31, 32,32') is actuated in the event of a fall.

25. A fall-arrest system as claimed in one or more of claims 1 to 23, in which, in use, the sliding device (17) is supported on the harness attachment point via the rigid or substantially rigid safety line (16), such that the sliding device (17) is maintained in a position so as to reduce relative to a fully flexible safety-line, the distance through which a person might otherwise free fall before the locking means (27,28,29,29',31) is actuated in the event of a fall.

26. A fall-arrest system as claimed in one or more of claims 1 to 23, in which, in use, the sliding device (17) is supported on the harness attachment point via the rigid or substantially rigid safety line (16) such that the sliding device (17) is maintained in an elevated position relative to the harness attachment point so as to reduce, relative to a fully flexible safety-line, the distance through which a person might otherwise free fall before the locking means is actuated in the event of a fall.

Patentansprüche

1. Absturzsicherungssystem für Personen, die in einer Höhe an einer Struktur mit länglichen Führungs- oder Bahnmitteln (1,3,5) in der Form einer Schiene, eines Seils, eines Kabels oder dergleichen arbeiten, das an der Struktur (4) so festlegbar ist, dass es benachbart zu einer beabsichtigten Route einer Person liegt, die die Struktur besteigt und/oder überquert und/oder von der Struktur absteigt, mit einer Gleiteinrichtung (17), die an die Führungs- oder Bahnmittel angekoppelt ist, um daran entlang frei verschiebbar zu sein, einer Sicherheitsleine (16), die sich von der Gleiteinrichtung (17) zur Befestigung bis an einen Geschirrbefestigungspunkt eines Sicherheitsgeschirrs (14) erstreckt, das von einer Person getragen wird, wobei die Gleiteinrichtung (17) Verriegelungsmittel (27,28,29, 29',31,32,32') umfasst, die es der Gleiteinrichtung erlauben, frei entlang der Führungs- oder Bahnmittel während einer normalen Bewegung einer Person zu gleiten, die damit mittels der Sicherheitsleine (16) verbunden ist, jedoch automatisch die Gleiteinrichtung mit den Führungs- oder Bahnmitteln verriegelt für den Fall, dass eine Person von der Struktur fällt oder stürzt, **dadurch gekennzeichnet, dass** wenigstens ein Abschnitt der Sicherheitsleine (16) von einem oder einer festen oder starren oder im Wesentlichen starren Rohr oder Röhre (25) umgeben ist oder wenigstens ein Abschnitt der Sicherheitsleine starr oder im Wesentlichen starr ist, so dass, wenn der Abschnitt der Führungs- oder Bahnmittel, an dem die Gleiteinrichtung (17) positioniert ist, in einer vertikalen oder geneigten Richtung orientiert wird, die Gleiteinrichtung an dem Geschirrbefestigungspunkt (18) mittels des Rohrs oder der Röhre (25) oder des im Wesentlichen starren Abschnitts der Sicherheitsleine (16) abgestützt ist, wobei die Gleiteinrichtung (17) über dem Geschirrbefestigungspunkt (18) gehalten ist und wobei der Abstand minimiert ist, durch den eine Person frei fallen kann, bevor die Verriegelungsmittel (27,28,29,29',31,32,32') im Falle eines Sturzes betätigt werden.

2. Absturzsicherungssystem nach Anspruch 1, wobei das oder die feste oder starre oder im Wesentlichen starre Rohr oder Röhre (25), das die Sicherheitsleine (16) umhüllt, daran entlang gleitbar ist.

3. Absturzsicherungssystem nach Anspruch 1 oder 2, wobei die Sicherheitsleine (16), die von dem festen oder starren oder im Wesentlichen starren Rohr (25) umgeben ist, ausziehbar ist, indem sie auf einer federbelasteten Rolle innerhalb des Körpers der Gleiteinrichtung (17) aufgewickelt ist, so dass sie selbsttätig ausziehbar und einziehbar ist, und einen weiteren Verriegelungsmechanismus (35) umfasst, um die Rolle zu verriegeln, wenn die Geschwindigkeit der Rolle eine vorbestimmte Grenze im Falle eines Sturzes übersteigt.

4. Absturzsicherungssystem nach einem der Ansprüche 1 bis 3, wobei das Rohr (25) eine feststehende Länge aufweist.

5. Absturzsicherungssystem nach einem der Ansprüche 1 bis 3, wobei das Rohr (25) teleskopierbar ausziehbar und einziehbar ist, um die Länge des im Wesentlichen starren Abschnitts der Sicherheitsleine anzupassen.

6. Absturzsicherungssystem nach einem der vorhergehenden Ansprüche, wobei die Verriegelungsmittel die Gleiteinrichtung mit den Führungs- oder Bahnmitteln als Folge einer Zugkraft verriegeln, die auf die Gleiteinrichtung (17) mittels der Sicherheitsleine (16) aufgebracht wird, wenn die Kraft eine Komponente aufweist, die parallel zu den Führungs- oder Bahnmitteln in einer Richtung von der Gleiteinrichtung weg geht.

7. Absturzsicherungssystem nach einem der vorhergehenden Ansprüche, wobei die Verriegelungsmittel einen Verriegelungshebel (27) aufweisen, der drehbar innerhalb eines Gehäuses (24) der Gleiteinrichtung zur Rotation um eine Achse montiert ist, wobei einer solchen Rotation durch eine Federwirkung Widerstand geleistet wird, die den Verriegelungshebel (27) in Richtung auf eine neutrale Position drängt, wobei sich der Verriegelungshebel im rechten Winkel zu den Führungs- oder Bahnmitteln erstreckt, wobei das distale Ende des Verriegelungshebels, das am weitesten von den Führungs- oder Bahnmitteln entfernt ist, mit der Sicherheitsleine (16) verbunden ist, und das gegenüberliegende Ende des Verriegelungshebels eine Verriegelungssperre (31) aufweist, wobei eine Drehbewegung des Verriegelungshebels in jeder Richtung aus der neutralen Position als Folge einer Kraft, die auf das gegenüberliegende Ende des Verriegelungshebels über die Sicherheitsleine in einer Richtung parallel zu den Führungs- und Bahnmitteln und weg von der Gleiteinrichtung aufgebracht wird, die Verriegelungssperre in Kontakt mit der Oberfläche der Führungs- oder Bahnmittel

bringt.

8. Absturzsicherungssystem nach Anspruch 7, wobei die Verriegelungssperre mit einem Bremsmaterial ausgekleidet ist.

9. Absturzsicherungssystem nach Anspruch 7 oder 8, wobei Stoppmittel (29,29') vorgesehen sind, die die Verriegelungssperre (31) von einer Betätigung der Oberfläche der Führungs- oder Bahnmittel abhalten, wenn eine Kraft auf den Verriegelungshebel über die Sicherheitsleine in einer Richtung parallel zu den Führungs- und Bahnmitteln und auf die Verriegelungseinrichtung aufgebracht wird, wobei die Verriegelungseinrichtung daran gehindert wird, betätigt zu werden, wenn eine stoßende Kraft auf die Gleiteinrichtung über die Sicherheitsleine aufgebracht wird.

10. Absturzsicherungssystem nach einem der vorhergehenden Ansprüche, wobei die Führungs- oder Bahnmittel (3,13) eine im Wesentlichen starre Schiene (1) mit sich nach außen erstreckenden Flanschabschnitten aufweisen, wobei die Gleiteinrichtung (17) Räder (21) umfasst, die die Rückseiten der Flanschabschnitte betätigen, wobei der Gleiteinrichtung erlaubt wird, entlang der Schiene zu gleiten, jedoch die Gleiteinrichtung daran gehindert wird, aus der Schiene gezogen zu werden in eine Richtung quer zur Schienenoberfläche.

11. Absturzsicherungssystem nach Anspruch 10, wobei die Schiene (1) einen hohlen Abschnitt hat, der einen Kanal (20) definiert, der entlang der Länge der Schiene läuft und in dem Heizmittel vorgesehen werden können, um zu verhindern, dass sich Eis auf der Schiene bildet, das ansonsten einen freien Durchgang der Gleiteinrichtung (17) behindern würde.

12. Absturzsicherungssystem nach Anspruch 11, wobei die Heizmittel einen Strom an aufgeheizter Flüssigkeit aufweisen, der durch den Kanal (20) gelangt, oder eine elektrisches Heizmittel aufweisen.

13. Absturzsicherungssystem nach einem der vorhergehenden Ansprüche, wobei eine Absturzsicherung (13) benachbart zur beabsichtigten Route einer Person vorgesehen ist, die die Struktur besteigt und/oder überquert und/oder von der Struktur absteigt, wobei die Führungs- oder Bahnmittel (3) integral mit der Absturzsicherung gebildet sind.

14. Absturzsicherungssystem nach einem der vorhergehenden Ansprüche, bei dem die Verriegelungseinrichtung zu einer Verriegelungsbewegung der Gleiteinrichtung an der Führung oder Bahn unabhängig von der Orientierung des Abschnitts der Führungs- oder Bahnmittel fähig ist, auf der die Gleiteinrichtung positioniert ist.

15. Absturzsicherungssystem nach einem der Ansprüche 1 bis 14, wobei die Verriegelungsmittel (27,28,29,29',31,32,32') die Bewegung der Gleiteinrichtung (17) als Antwort auf eine Kraft verriegeln, die über die Sicherheitsleine (16) im Falle eines Sturzes einer damit verbundenen Person aufgebracht wird.

16. Absturzsicherungssystem nach einem der Ansprüche 14 oder 15, wobei die Verriegelungsmittel (27,28,29,29',31,32,32') einen Verriegelungshebel aufweisen, der drehbar innerhalb eines Gehäuses der Gleiteinrichtung (17) zur Rotation um eine Achse montiert ist, wobei einer derartigen Rotation durch eine Federwirkung Widerstand geleistet wird, die den Verriegelungshebel in eine neutrale Position drängt, wobei der Verriegelungshebel sich im rechten Winkel zu den Führungs- oder Bahnmitteln erstreckt, wobei das distale Ende des Verriegelungshebels, das am weitesten von den Führungs- oder Bahnmitteln entfernt ist, mit der Sicherheitsleine verbunden ist und das gegenüberliegende Ende des Verriegelungshebels eine Verriegelungssperre aufweist, wobei eine Drehbewegung des Verriegelungshebels in jeder Richtung aus der neutralen Position als Antwort auf eine Kraft, die auf das gegenüberliegende Ende des Verriegelungshebels mittels der Sicherheitsleine in einer Richtung parallel zu den Führungs- oder Bahnmitteln und weg von der Gleiteinrichtung aufgebracht wird, die Verriegelungssperre in Kontakt mit der Oberfläche der Führungs- oder Bahnmittel bringt.

17. Absturzsicherungssystem nach Anspruch 16, wobei die Verriegelungssperre mit einem Bremsmaterial ausgekleidet ist.

18. Absturzsicherungssystem nach Anspruch 17 oder 18, wobei Stoppmittel (29,29') vorgesehen sind, die die Verriegelungssperre (31) an einer Betätigung der Oberfläche der Führungs- oder Bahnmittel hindern, wenn eine Kraft auf den Verriegelungshebel (27) mittels der Sicherheitsleine in einer Richtung parallel zu den Führungs- oder Bahnmitteln und auf die Verriegelungseinrichtung aufgebracht wird, wobei die Verriegelungsmittel daran gehindert werden, betätigt zu werden, wenn eine stoßende Kraft auf die Gleiteinrichtung über die Sicherheitsleine aufgebracht wird.

19. Absturzsicherungssystem nach einem der Ansprüche 1 bis 18, die auch ein Sicherheitsgeschirr (14) umfasst, dass von einer Person getragen wird, um die Person im Falle eine Sturzes aus der Höhe zu schützen, wobei dass Sicherheitsgeschirr Bandmittel aufweist, die sich über einen Abschnitt eines Körpers einer Person erstrecken, um eine Person innerhalb des Sicherheitsgeschirrs zurückzuhalten, wo-

bei ein Extensionsgurt sich von einem hinteren Abschnitt des Geschirrs erstreckt, welcher Abschnitt bei Gebrauch benachbart zum Rücken des Trägers ist, wobei Befestigungsmittel benachbart zu dem Extensionsgurt oder an einem distalen Ende des Extensionsgurts zur Verbindung mit einer Sicherheitsleine oder einem Lanyard (16) vorgesehen sind und Verbindungsmittel (15) an einem vorderen Abschnitt des Sicherheitsgeschirrs vorgesehen sind, welcher Abschnitt bei Gebrauch benachbart zur Brust des Trägers ist, wobei die Befestigungsmittel des Extensionsgurts lösbar mit den Verbindungsmitteln verbindbar sind, so dass, wenn das Befestigungsmittel mit dem Verbindungsmittel verbunden ist, das Befestigungsmittel einen vorderen Geschirrbefestigungspunkt (15) für die Sicherheitsleine vorsieht und, wenn das Befestigungsmittel nicht mit dem Verbindungsmittel verbunden ist, das Befestigungsmittel einen dorsalen Geschirrsbefestigungspunkt für die Sicherheitsleine kraft des Extensionsgurts vorsieht, wobei die Anordnung es dem Geschirrbefestigungspunkt erlaubt von den vorderen zu den dorsalen Stellungen bewegt zu werden und umgekehrt, ohne dass eine Aufhebung der Verbindung der Sicherheitsleine mit den Befestigungsmitteln erforderlich ist und eine Ausdehnung der Sicherheitsleine vorgesehen ist, wenn sie mit dem dorsalen Geschirrbefestigungspunkt kraft des Extensionsgurts verbunden ist.

20. Absturzsicherungssystem und Sicherheitsgeschirr nach Anspruch 19, wobei, wenn die Befestigungsmittel des Extensionsgurts mit den Verbindungsmitteln auf der Vorderseite des Geschirrs verbunden sind, die Dehnleine über eine Schulter des Trägers gelangt.

21. Absturzsicherungssystem nach einem der Ansprüche 1 bis 20, wobei sie auch eine Führungseinrichtung für das Absturzsicherungssystem mit einem ersten Führungsabschnitt (38), der um einen ersten Winkel geneigt ist, und einem zweiten Führungsabschnitt umfasst, der um einen zweiten Winkel geneigt ist, wobei der zweite Winkel vom ersten Winkel verschieden ist und eine Übergangseinrichtung (9) vorgesehen ist, wobei die Übergangseinrichtung es einer Gleiteinrichtung erlaubt, die gleitbar an der Führung montiert ist, von dem ersten Führungsabschnitt zum zweiten Führungsabschnitt zu gelangen, ohne von der Führungseinrichtung gelöst zu werden, wobei die Übergangseinrichtung (9) einen schwenkbaren Abschnitt an Bahn oder Führung aufweist, der drehbar zur Bewegung zwischen einer ersten Position, in der der schwenkbar Abschnitt in Linie mit dem ersten Führungsabschnitt ist und eine Fortsetzung des ersten Führungsabschnitts bildet, und einer zweiten Position montiert ist, in der der Abschnitt der Führung oder Bahn in Linie mit dem zweiten Führungsabschnitt ist und eine Fortsetzung des zweiten Führungsabschnitts bildet, wobei erste und zweite Verriegelungsmittel (39,42) zur Verriegelung des schwenkbaren Abschnitts in seiner ersten bzw. zweiten Stellung vorgesehen ist, wobei erste und zweite Rückhaltemittel benachbart zu den gegenüberliegenden Enden des schwenkbaren Abschnitts vorgesehen sind, wobei die ersten und zweiten Rückhaltemittel (40,41) unabhängig zwischen einer nicht betriebsfähigen Stellung, in der eine Gleiteinrichtung hinter dem jeweiligen Rückhaltemittel sich bewegen kann, um auf oder von dem schwenkbaren Abschnitt weg zu gelangen, und einer betriebsfähigen Stellung bewegbar ist, in der eine Gleiteinrichtung (17) daran gehindert wird, sich hinter dem jeweiligen Rückhaltemittel zu bewegen.

22. Absturzsicherungssystem nach einem Ansprüche 1 bis 21, wobei sie auch eine zusammenklappbare Absturzsicherung (13, Fig. 6) zur Befestigung an einer Struktur benachbart zu einer beabsichtigten Route einer Person umfasst, die die Struktur besteigt und/oder überquert und/oder von der Struktur absteigt, wobei die Absturzsicherung Schwenkmittel aufweist, die es der Absturzsicherung erlaubt zwischen einer aufgerichteten betriebsfähigen Stellung, in der die Absturzsicherung sich im Wesentlichen im rechten Winkel von der Oberfläche der Struktur erstreckt, und einer zusammengeklappten Stellung bewegt zu werden, in der die Absturzsicherung im Wesentlichen parallel zu der Oberfläche der Struktur liegt, wobei Verriegelungsmittel zur Verriegelung der Absturzsicherung sowohl in ihrer betriebsfähigen als auch in der zusammengeklappten Stellung vorgesehen sind.

23. Absturzsicherungssystem mit einer zusammenklappbaren Absturzsicherung nach Anspruch 22, wobei die Verriegelungsmittel einen Anschlag oder eine Falle (39) aufweisen, der oder die den Schwenkmitteln zugeordnet ist.

24. Absturzsicherungssystem nach einem oder mehreren der Ansprüche 1 bis 23, bei dem bei Gebrauch die Gleiteinrichtung (17) an dem Geschirrbefestigungspunkt über die feste oder starre oder im Wesentlichen starre Sicherheitsleine (16) so abgestützt ist, dass die Gleiteinrichtung (17) über mit dem Geschirrbefestigungspunkt gehalten wird, um relativ zu einer voll flexiblen Sicherheitsleine den Abstand zu verringern, durch den eine Person ansonsten frei fallen kann, bevor das Verriegelungsmittel (27,28,29, 29',31,32,32') im Fall eines Sturzes betätigt wird.

25. Absturzsicherungssystem nach einem oder mehreren der Ansprüche 1 bis 23, bei dem bei Gebrauch die Gleiteinrichtung (17) an dem Geschirrbefestigungspunkt mittels einer festen oder starren oder im

Wesentlichen starren Sicherheitsleine (16) abgestürzt wird, so dass die Gleiteinrichtung (17) in einer Stellung gehalten wird, um relativ zu einer voll flexiblen Sicherheitsleine den Abstand zu verringern, durch den eine Person ansonsten frei fallen kann, bevor das Verriegelungsmittel (27,28,29,29', 31,32,32') im Fall eines Sturzes verriegelt wird.

26. Absturzsicherungssystem nach einem oder mehreren der Ansprüche 1 bis 23, bei dem bei Gebrauch die Gleiteinrichtung (17) an dem Geschirrbefestigungspunkt mittels einer festen oder starren oder im Wesentlichen starren Sicherheitsleine (16) abgestützt wird, so dass die Gleiteinrichtung (17) in einer relativ zum Geschirrbefestigungspunkt erhöhten Stellung gehalten wird, um relativ zu einer voll flexiblen Sicherheitsleine den Abstand zu verringern, durch den eine Person ansonsten frei fallen kann, bevor das Verriegelungsmittel im Fall eines Sturzes betätigt wird.

Revendications

1. Système antichute pour des personnes travaillant en hauteur sur une structure, comprenant un moyen de guidage allongé (1, 3, 5) sous la forme d'un rail, d'une corde, d'un câble ou l'équivalent, pouvant être fixé à la structure (4) de façon à se situer en position adjacente à l'itinéraire prévu d'une personne qui monte et/ou traverse et/ou descend de la structure, un dispositif coulissant (17) étant couplé au moyen de guidage de façon à être librement déplaçable le long de celui-ci, une longe de sécurité (16) s'étendant à partir du dispositif coulissant (17) pour la fixation à un point de fixation au harnais d'un harnais de sécurité (14) porté par une personne, le dispositif coulissant (17) incorporant un moyen de blocage (27, 28, 29, 29', 31, 32, 32') permettant au dispositif coulissant de glisser librement le long du moyen de guidage pendant le déplacement normal d'une personne reliée à celui-ci au moyen de la longe de sécurité (16) mais verrouillant automatiquement le dispositif coulissant au moyen de guidage dans le cas où une personne tomberait de ladite structure, **caractérisé en ce que** au moins une portion de la longe de sécurité (16) est gainée par un tube ou tuyau rigide ou substantiellement rigide (25) ou bien au moins une portion de la longe de sécurité est rigide ou substantiellement rigide, de telle façon que, lorsque la portion du moyen de guidage sur laquelle le dispositif coulissant (17) est positionné est orientée dans une direction verticale ou inclinée, le dispositif coulissant est supporté sur le point de fixation au harnais (18) par l'intermédiaire du tube ou tuyau (25) ou de la portion substantiellement rigide de la longe de sécurité (16), maintenant le dispositif coulissant (17) au-dessus du point de fixation au harnais (18) et minimisant la distance sur laquelle une personne pourrait tomber en chute libre avant que le moyen de blocage (27, 28, 29, 29', 31, 32, 32') ne soit actionné en cas de chute.

2. Système antichute selon la revendication 1, dans lequel le tube ou tuyau rigide ou substantiellement rigide (25) gainant la longe de sécurité (16) est apte à glisser le long de celle-ci.

3. Système antichute selon la revendication 1 ou 2, dans lequel la longe de sécurité (16) gainée par le tube rigide ou substantiellement rigide (25) est extensible en étant enroulée sur un enrouleur à ressort à l'intérieur du corps du dispositif coulissant (17) de telle façon qu'elle est automatiquement apte à s'étendre et à se rétracter et incorpore en outre un mécanisme de blocage (35) afin de bloquer l'enrouleur si la vitesse de l'enrouleur dépasse une limite prédéterminée en cas de chute.

4. Système antichute selon l'une quelconque des revendications 1 à 3, dans lequel le tube (25) est de longueur fixe.

5. Système antichute selon l'une quelconque des revendications 1 à 3, dans lequel le tube (25) est extensible et rétractable de façon télescopique afin de régler la longueur de ladite portion substantiellement rigide de la longe de sécurité.

6. Système antichute selon l'une quelconque, des revendications précédentes, dans lequel le moyen de blocage verrouille le dispositif coulissant au moyen de guidage en réponse à une force de traction appliquée au dispositif coulissant (17) par l'intermédiaire de la longe de sécurité (16) lorsque ladite force a une composante parallèle au moyen de guidage dans une direction s'écartant du dispositif coulissant.

7. Système antichute selon l'une quelconque des revendications précédentes, dans lequel le moyen de blocage comprend un levier de blocage (27) monté de façon pivotante à l'intérieur d'un boîtier (24) du dispositif coulissant en vue d'une rotation autour d'un axe, une telle rotation étant contrée par un effet de ressort qui pousse le levier de blocage (27) en direction d'une position neutre dans laquelle le levier de blocage s'étend perpendiculairement au moyen de guidage, l'extrémité distale du levier de blocage la plus éloignée du moyen de guidage étant connectée à la longe de sécurité (16), l'extrémité opposée du levier de blocage comprenant un cliquet de blocage (31), le mouvement pivotant du levier de blocage dans l'une ou l'autre direction à l'écart de ladite position neutre, en réponse à une force appliquée à ladite extrémité opposée du levier de blocage, par l'intermédiaire de la longe de sécurité, dans une di-

rection parallèle au moyen de guidage et s'écartant du dispositif coulissant amenant ledit cliquet de blocage en contact avec la surface du moyen de guidage.

8. Système antichute selon la revendication 7, dans lequel le cliquet de blocage (31) est revêtu d'un matériau de freinage.

9. Système antichute selon la revendication 7 ou 8, dans lequel des moyens d'arrêt (29, 29') sont fournis, empêchant le cliquet de blocage (31) de venir en prise avec la surface du moyen de guidage lorsqu'une force est appliquée au levier de blocage, par l'intermédiaire de la longe de sécurité, dans une direction parallèle au moyen de guidage et en direction du dispositif de blocage, empêchant le dispositif de blocage d'être actionné lorsqu'une force de poussée est appliquée au dispositif coulissant par l'intermédiaire de la longe de sécurité.

10. Système antichute selon l'une quelconque des revendications précédentes, dans lequel le moyen de guidage (3, 5) comprend un rail substantiellement rigide (1) présentant des portions de bride s'étendant vers l'extérieur, le dispositif coulissant (17) incluant des roulettes (21) venant en prise avec les faces arrières desdites portions de bride, permettant au dispositif coulissant de coulisser le long du rail mais empêchant le dispositif coulissant d'être arraché du rail dans une direction transversale par rapport à la surface du rail.

11. Système antichute selon la revendication 10, dans lequel le rail (1) présente une section creuse définissant un canal (20) courant le long de la longueur du rail dans lequel un moyen de chauffage peut être fourni pour empêcher de la glace de se former sur le rail, qui empêcherait autrement le libre passage du dispositif coulissant (17).

12. Système antichute selon la revendication 11, dans lequel le moyen de chauffage comprend un courant de liquide chauffé passant à travers le canal (20) ou comprend un moyen de chauffage électrique.

13. Système antichute selon l'une quelconque des revendications précédentes, dans lequel un garde-corps (13) est fourni en position adjacente à l'itinéraire prévu d'une personne montant et/ou traversant et/ou descendant de la structure, le moyen de guidage (3) pouvant être réalisé solidaire du garde-corps.

14. Système antichute selon l'une quelconque des revendications précédentes, dans lequel le moyen de blocage est capable de bloquer le déplacement du dispositif coulissant sur le moyen de guidage quelle que soit l'orientation de la portion du moyen de guidage sur laquelle le dispositif coulissant est positionné.

15. Système antichute selon l'une quelconque des revendications 1 à 14, dans lequel le moyen de blocage (27, 28, 29, 29', 31, 32, 32') bloque le déplacement du dispositif coulissant (17) en réponse à une force appliquée par l'intermédiaire de la longe de sécurité (16) en cas de chute d'une personne reliée à celle-ci.

16. Système antichute selon l'une quelconque des revendications 14 et 15, dans lequel le moyen de blocage (27, 28, 29, 29', 31, 32, 32') comprend un levier de blocage (27) monté de façon pivotante à l'intérieur d'un boîtier du dispositif coulissant (17) en vue d'une rotation autour d'un axe, une telle rotation étant contrée par un effet de ressort qui pousse le levier de blocage en direction d'une position neutre dans laquelle le levier de blocage s'étend perpendiculairement au moyen de guidage, l'extrémité distale du levier de blocage la plus éloignée du moyen de guidage étant connectée à la longe de sécurité, l'extrémité opposée du levier de blocage comprenant un cliquet de blocage, le mouvement pivotant du levier de blocage dans l'une ou l'autre direction à l'écart de ladite position neutre, en réponse à une force appliquée à ladite extrémité opposée du levier de blocage, par l'intermédiaire de la longe de sécurité, dans une direction parallèle au moyen de guidage et s'écartant du dispositif coulissant amenant ledit cliquet de blocage en contact avec la surface du moyen de guidage.

17. Système antichute selon la revendication 16, dans lequel le cliquet de blocage est revêtu d'un matériau de freinage.

18. Système antichute selon la revendication 17 ou la revendication 18, dans lequel des moyens d'arrêt (29, 29') sont fournis empêchant le cliquet de blocage (31) de venir en prise avec la surface du moyen de guidage lorsqu'une force est appliquée au levier de blocage (27), par l'intermédiaire de la longe de sécurité, dans une direction parallèle au moyen de guidage et en direction du dispositif de blocage, empêchant le moyen de blocage d'être actionné lorsqu'une force de poussée est appliquée au dispositif coulissant par l'intermédiaire de la longe de sécurité.

19. Système antichute selon l'une quelconque des revendications 1 à 18, comprenant aussi un harnais de sécurité (14) destiné à être porté par une personne pour protéger la personne en cas de chute d'une certaine hauteur, le harnais de sécurité comprenant des moyens de sangles destinés à s'étendre sur une partie du corps d'une personne afin de retenir une personne à l'intérieur du harnais de sécurité, une

sangle d'extension s'étendant à partir d'une portion arrière du harnais, laquelle portion est, en service, en position adjacente au dos du porteur, un moyen de fixation étant fourni en position adjacente à ou bien au niveau d'une extrémité distale de la sangle d'extension pour la connexion à une longe de sécurité ou corde de retenue (16), le moyen de connexion (15) étant fourni sur une portion avant du harnais de sécurité, laquelle portion est, en service, adjacente à la poitrine du porteur, le moyen de fixation de la sangle d'extension pouvant être connecté de façon amovible au moyen de connexion de telle façon que, lorsque le moyen de fixation est connecté au moyen de connexion, le moyen de fixation fournit un point de fixation avant au harnais (15) pour la longe de sécurité et que, lorsque le moyen de fixation n'est pas connecté au moyen de connexion, le moyen de fixation fournit un point de fixation dorsal au harnais pour la longe de sécurité du fait de la sangle d'extension, l'agencement permettant au point de fixation au harnais d'être déplacé de la position avant à la position dorsale, et vice versa, sans qu'il soit nécessaire de déconnecter la longe de sécurité du moyen de fixation et fournissant une extension à la longe de sécurité lorsqu'elle est connectée au point de fixation dorsal au harnais du fait de la sangle d'extension.

20. Système antichute et harnais de sécurité selon la revendication 19, dans lequel, lorsque le moyen de fixation de la sangle d'extension est connecté au moyen de connexion à l'avant du harnais, la sangle d'extension passe au-dessus d'une épaule du porteur.

21. Système antichute selon l'une quelconque des revendications 1 à 20, comprenant aussi un ensemble de guidage pour le système antichute incluant une première section de guidage (38) inclinée sous un premier angle et une seconde section de guidage inclinée sous un second angle, le second angle étant différent du premier angle, et un dispositif de permutation (9), le dispositif de permutation permettant à un dispositif coulissant monté de façon coulissante sur le guide de passer de la première section de guidage à la seconde section de guidage sans être libéré de l'ensemble de guidage, ledit dispositif de permutation (9) comprenant une section basculante de guidage qui est montée de façon pivotante en vue du mouvement entre une première position dans laquelle ladite section basculante est alignée avec et forme une continuation de la première section de guidage et une seconde position dans laquelle ladite section de guidage est alignée avec et forme une continuation de la seconde section de guidage, un premier et un second moyens de blocage (39, 42) étant fournis pour bloquer la section basculante respectivement dans sa première et sa seconde positions, un premier et un second moyens de retenue étant fournis en position adjacente aux extrémités opposées de la section basculante, lesdits premier et second moyens de retenue (40, 41) étant mobiles de façon indépendante entre une position de non-fonctionnement dans laquelle un dispositif coulissant peut franchir le moyen de retenue correspondant afin de passer sur ou de quitter la section basculante et une position de fonctionnement dans laquelle un dispositif coulissant (17) est empêché de franchir le moyen de retenue correspondant.

22. Système antichute selon l'une quelconque des revendications 1 à 21, comprenant aussi un garde-corps rabattable (13, fig. 6) servant à sécuriser une structure adjacente à l'itinéraire prévu d'une personne montant et/ou traversant et/ou descendant de la structure, ledit garde-corps comprenant un moyen de pivot permettant au garde-corps d'être mobile entre une position de fonctionnement relevée, dans laquelle le garde-corps s'étend substantiellement perpendiculairement à partir de la surface de ladite structure, et une position rabattue dans laquelle le garde-corps se situe substantiellement parallèlement à la surface de ladite structure, des moyens de blocage étant fournis pour bloquer le garde-corps dans sa position soit de fonctionnement, soit rabattue.

23. Système antichute comprenant un garde-corps rabattable selon la revendication 22, dans lequel ledit moyen de blocage comprend un verrouillage (39) associé audit moyen de pivot.

24. Système antichute selon une ou plusieurs des revendications 1 à 23, dans lequel, en service, le dispositif coulissant (17) est supporté au point de fixation au harnais par l'intermédiaire de la longe de sécurité (16) rigide ou substantiellement rigide de telle façon que le dispositif coulissant (17) est maintenu au-dessus du point de fixation au harnais de façon à réduire, par rapport à une longe de sécurité entièrement souple, la distance sur laquelle une personne pourrait autrement tomber librement avant que le moyen de blocage (27, 28, 29, 29', 31, 32, 32') ne soit actionné en cas de chute.

25. Système antichute selon une ou plusieurs des revendications 1 à 23, dans lequel, en service, le dispositif coulissant (17) est supporté au point de fixation au harnais par l'intermédiaire de la longe de sécurité (16) rigide ou substantiellement rigide de telle façon que le dispositif coulissant (17) est maintenu dans une position permettant de réduire, par rapport à une longe de sécurité entièrement souple, la distance sur laquelle une personne pourrait autrement tomber librement avant que le moyen de blocage (27, 28, 29, 29', 31, 32, 32') ne soit actionné en cas

de chute.

26. Système antichute selon une ou plusieurs des revendications 1 à 23, dans lequel, en service, le dispositif coulissant (17) est supporté au point de fixation au harnais par l'intermédiaire de la longe de sécurité (16) rigide ou substantiellement rigide de telle façon que le dispositif coulissant (17) est maintenu dans une position surélevée par rapport au point de fixation au harnais de manière à réduire, par rapport à une longe de sécurité entièrement souple, la distance sur laquelle une personne pourrait autrement tomber librement avant que le moyen de blocage ne soit actionné en cas de chute.

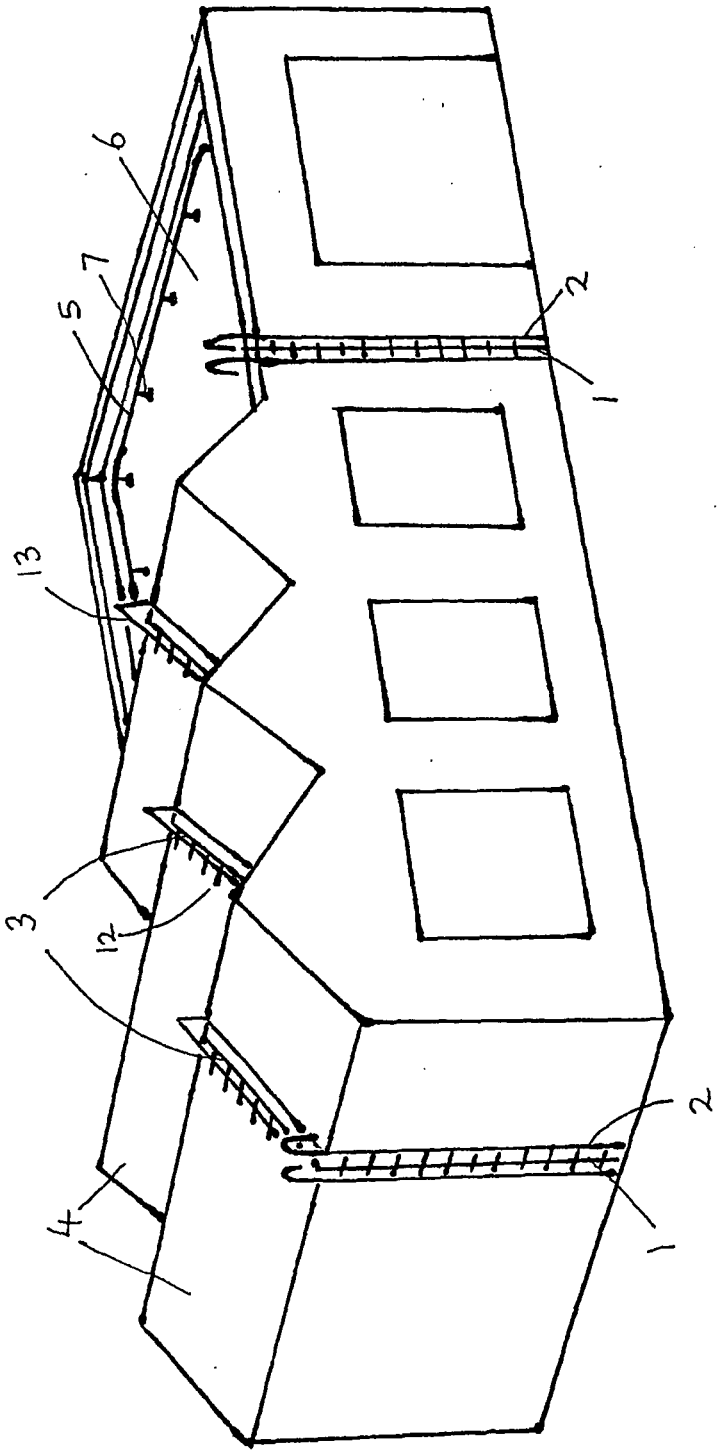


Fig 1

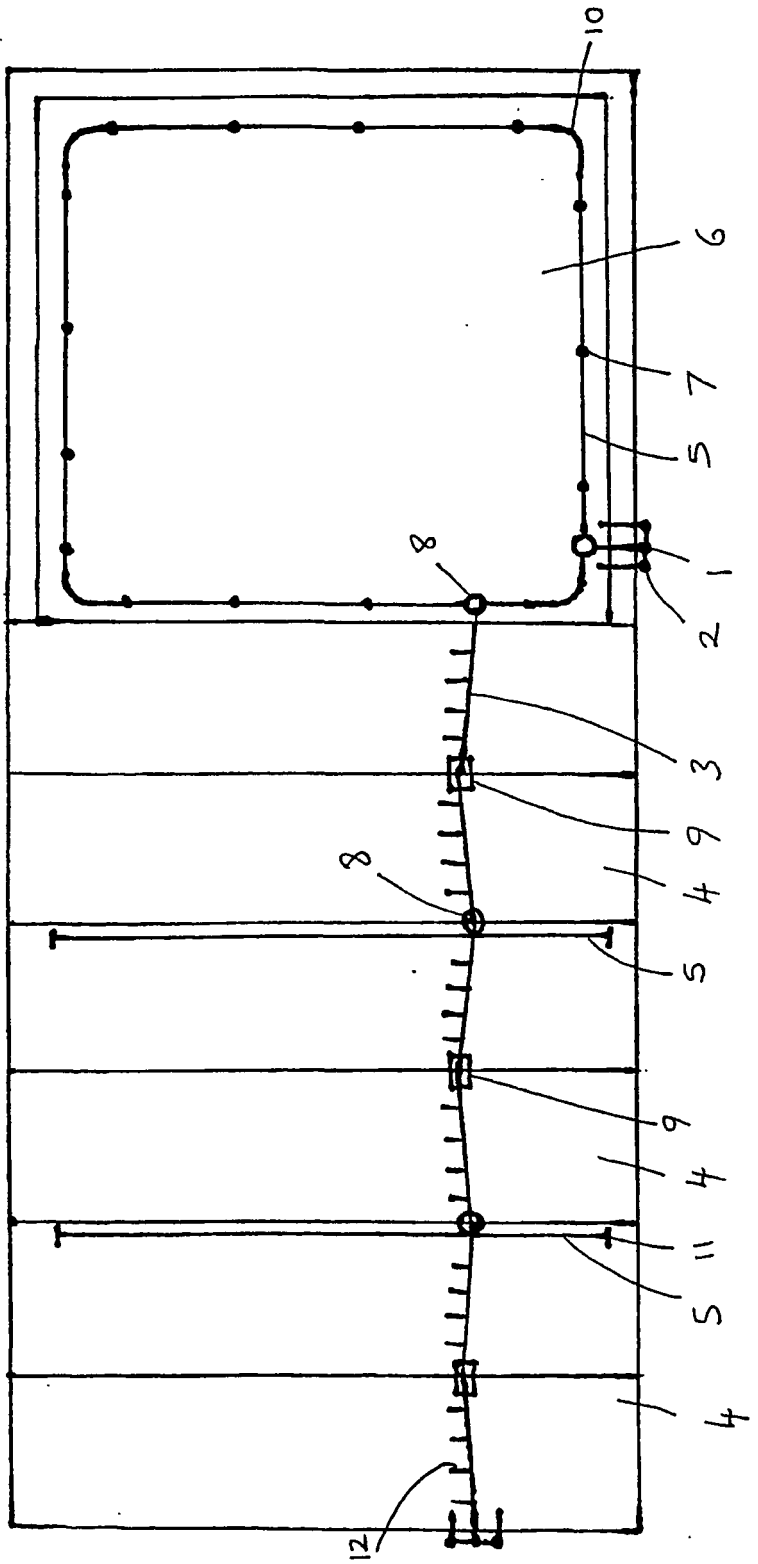


Fig 2

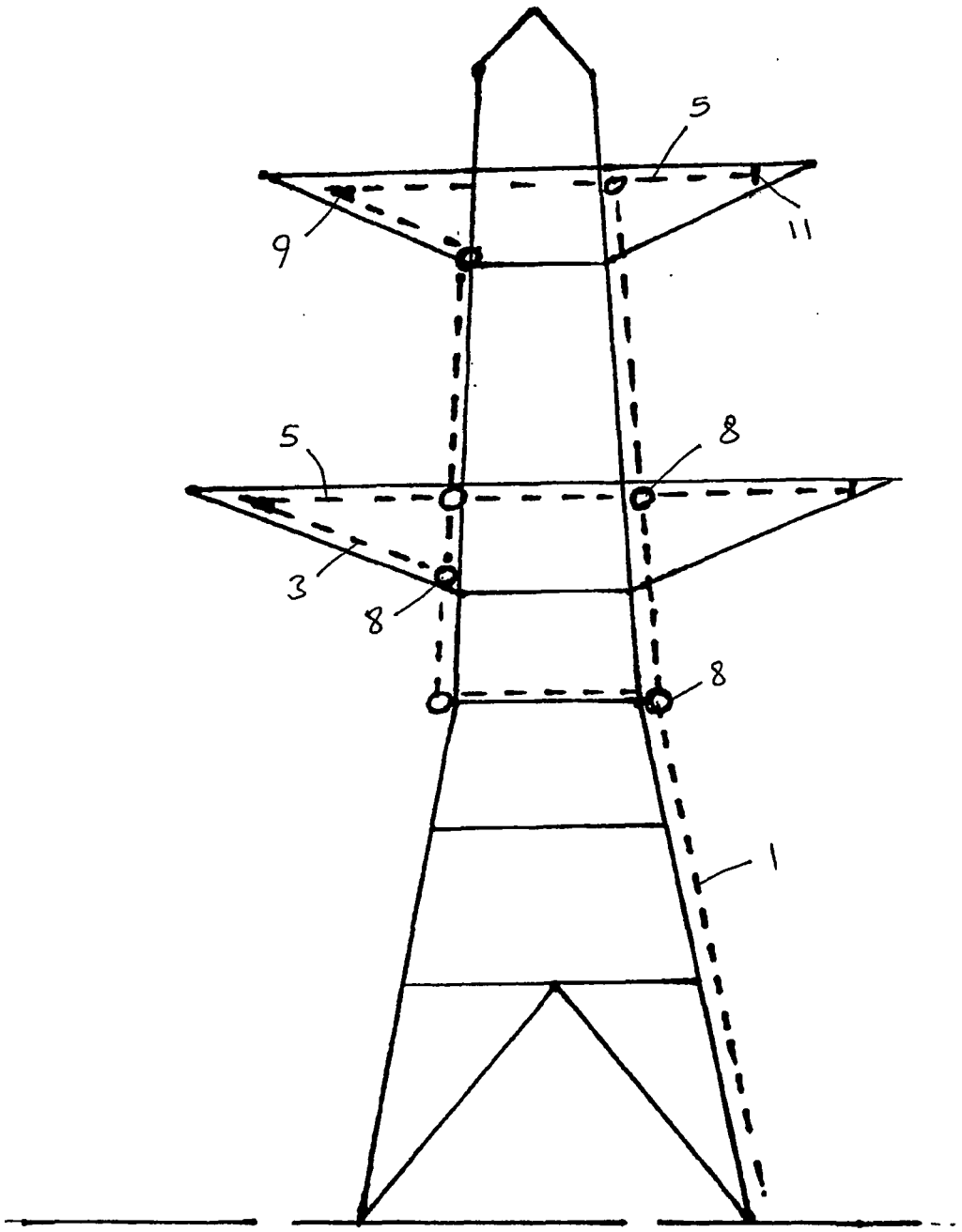


Fig 3

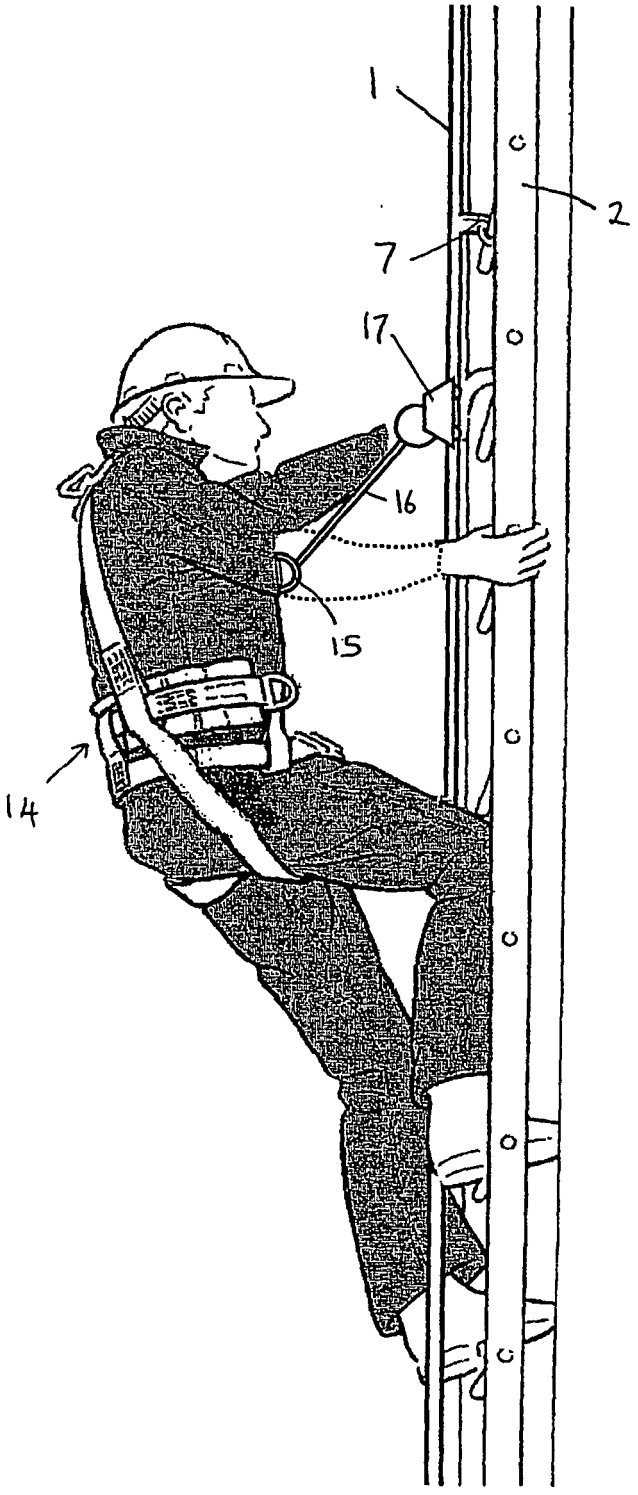


Fig 4

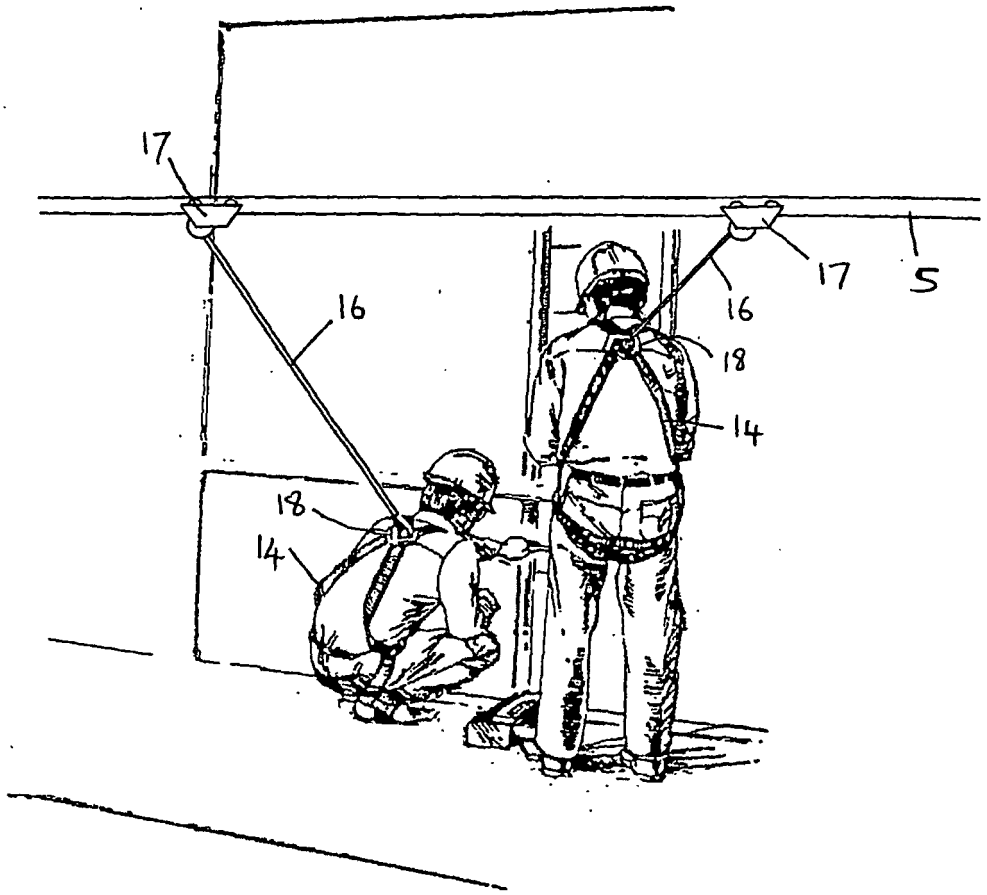


Fig 5

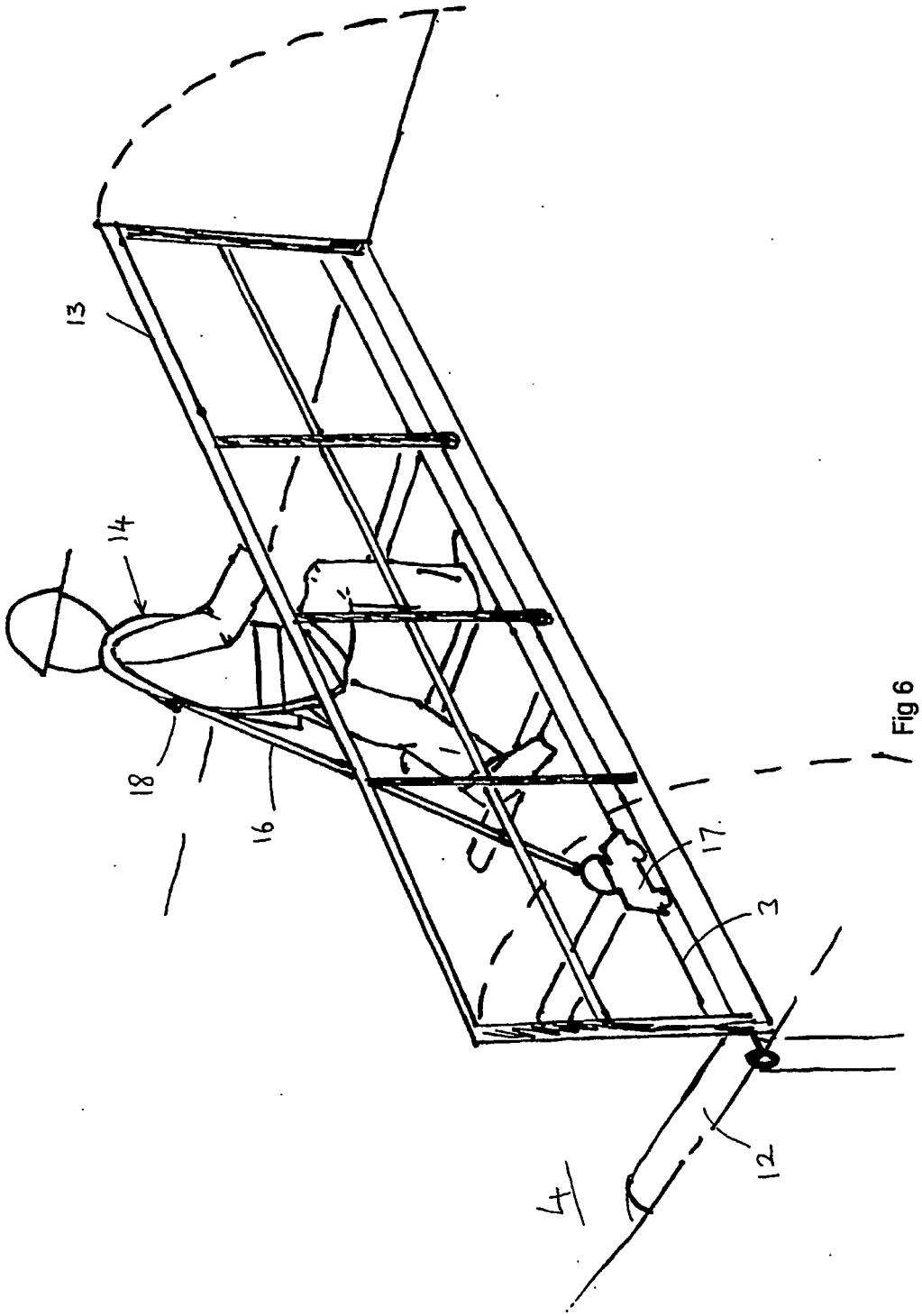


Fig 6

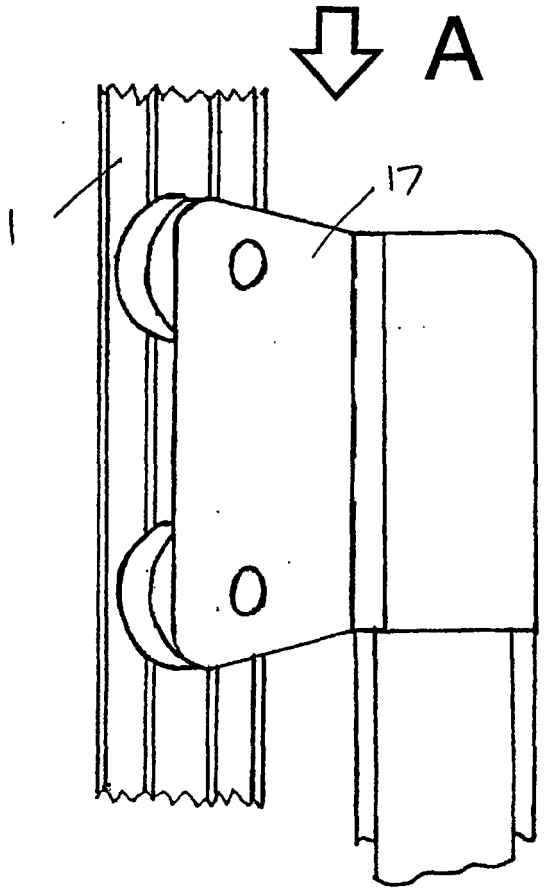


Fig. 7a

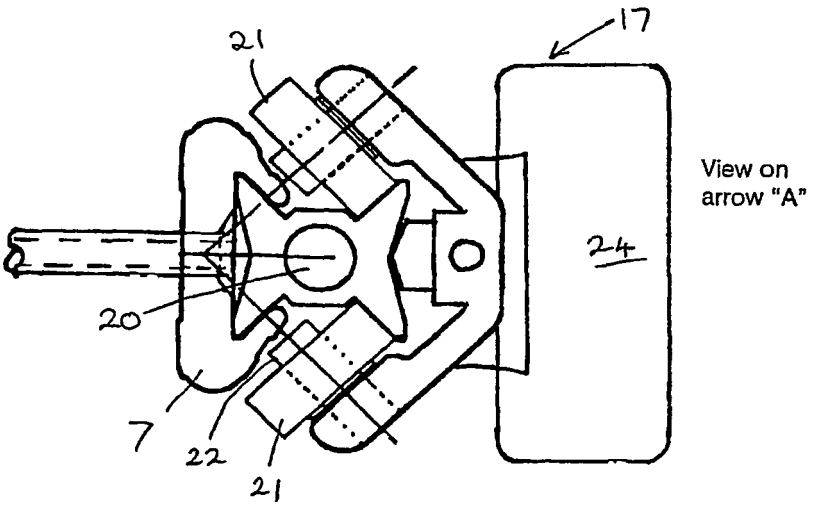


Fig 7b

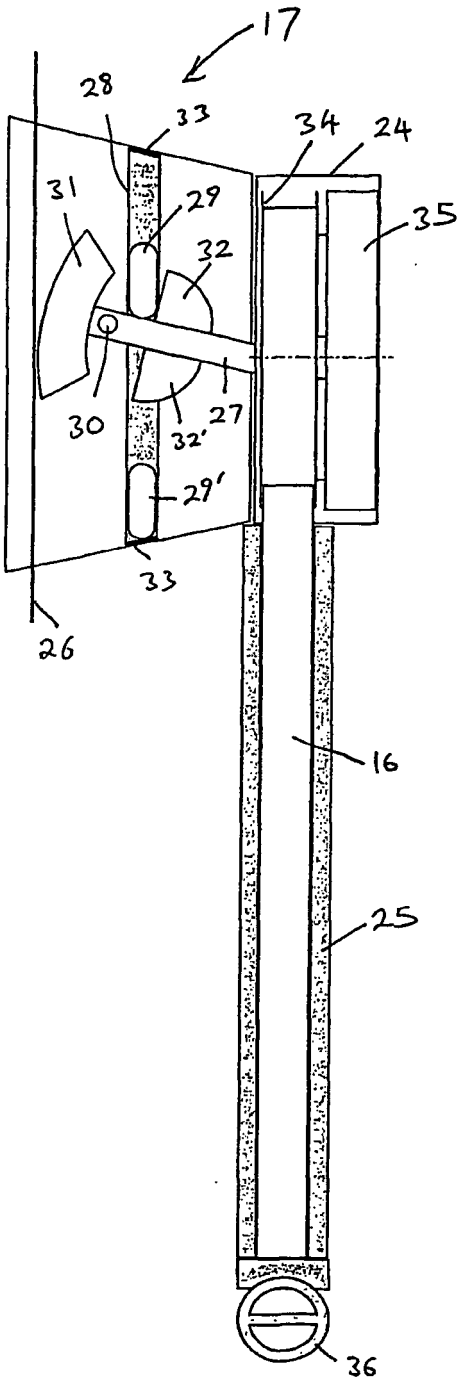

17
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Fig. 8a

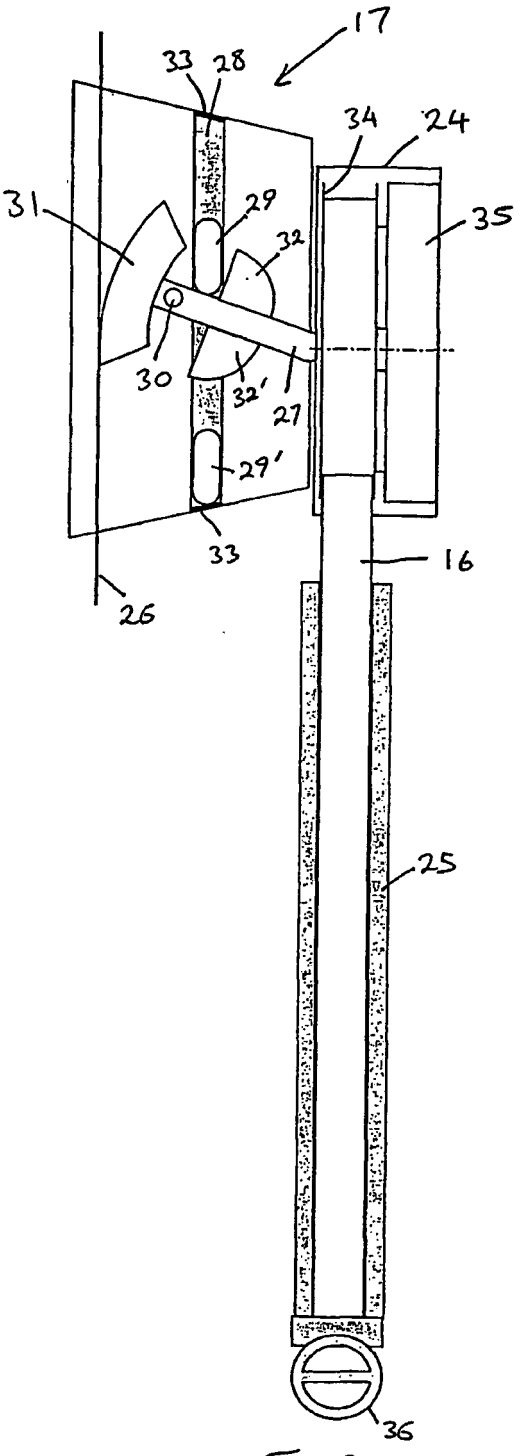

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Fig. 8b

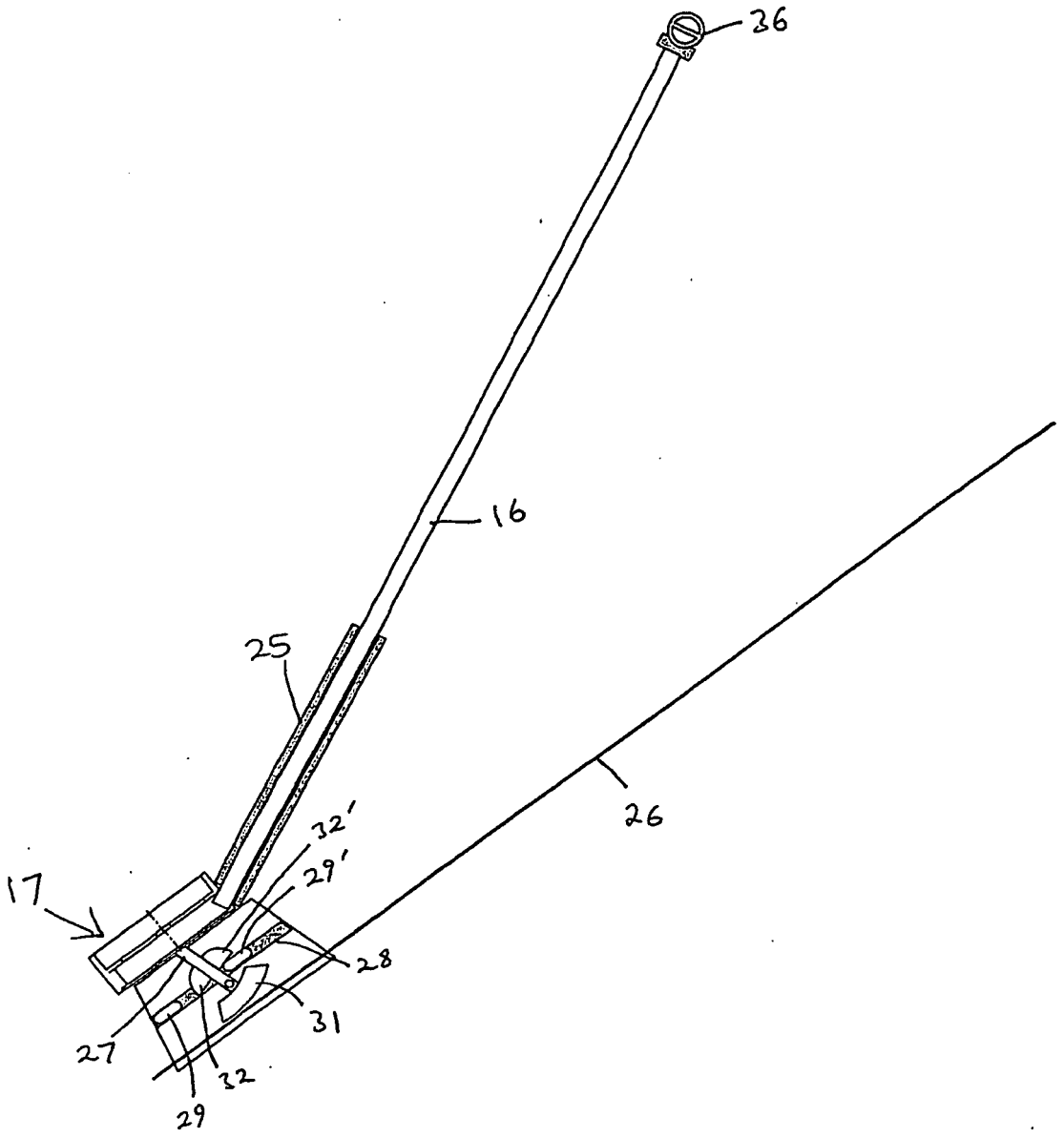


Fig 9

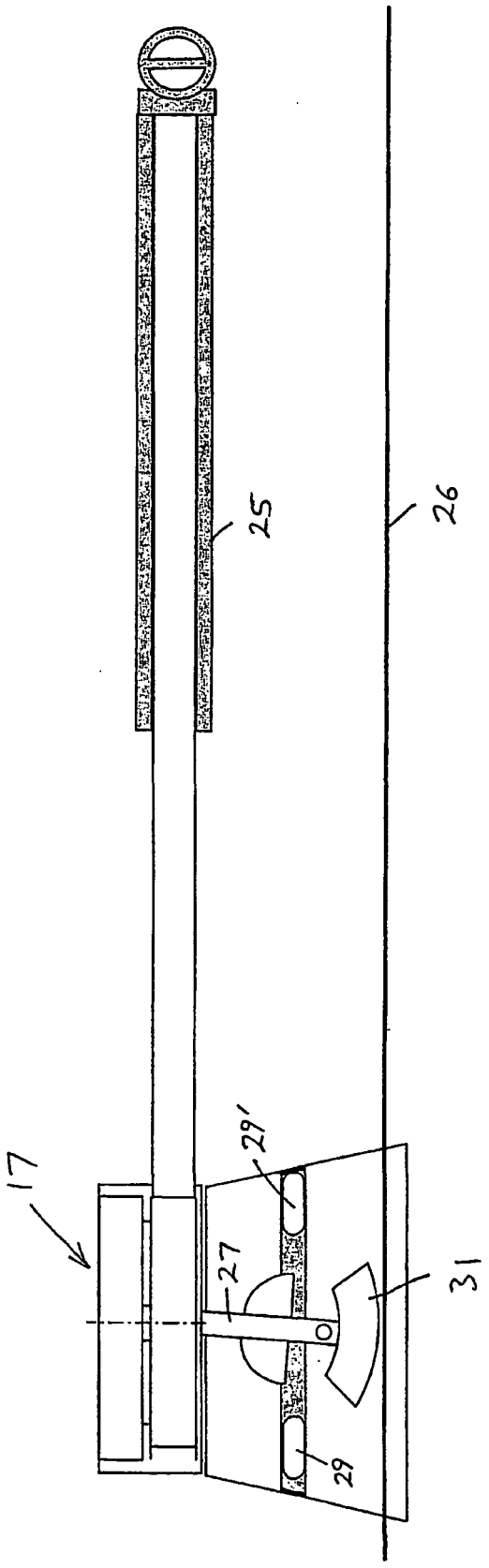


Fig 10

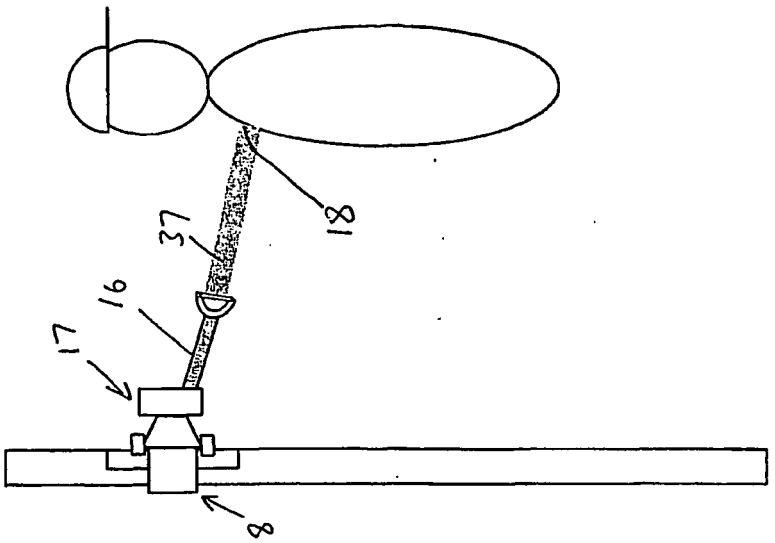


Fig. 11c

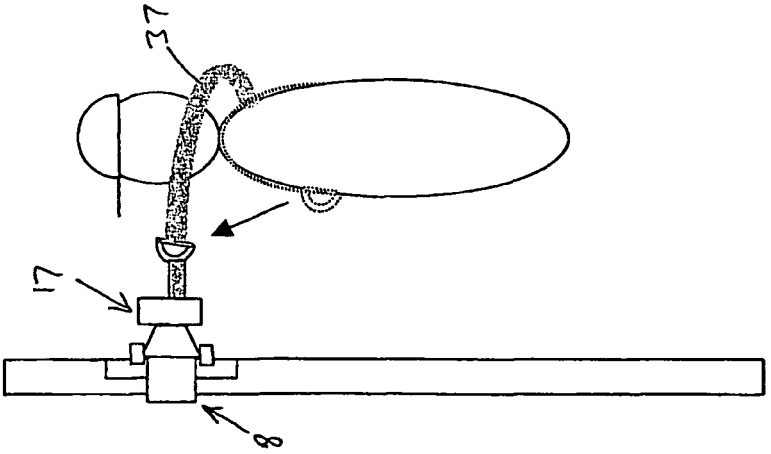


Fig. 11b

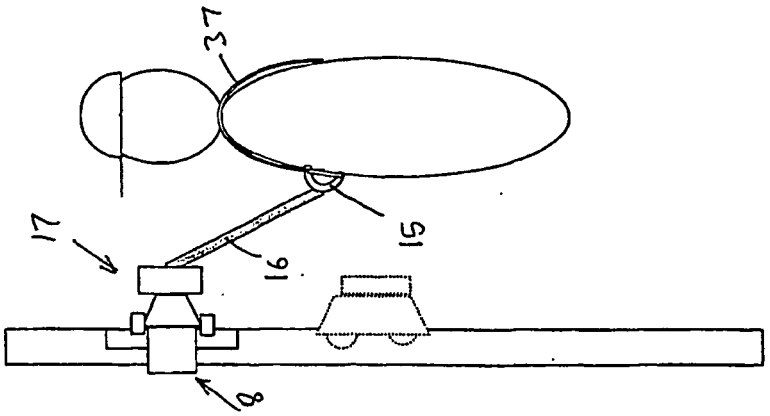


Fig. 11a

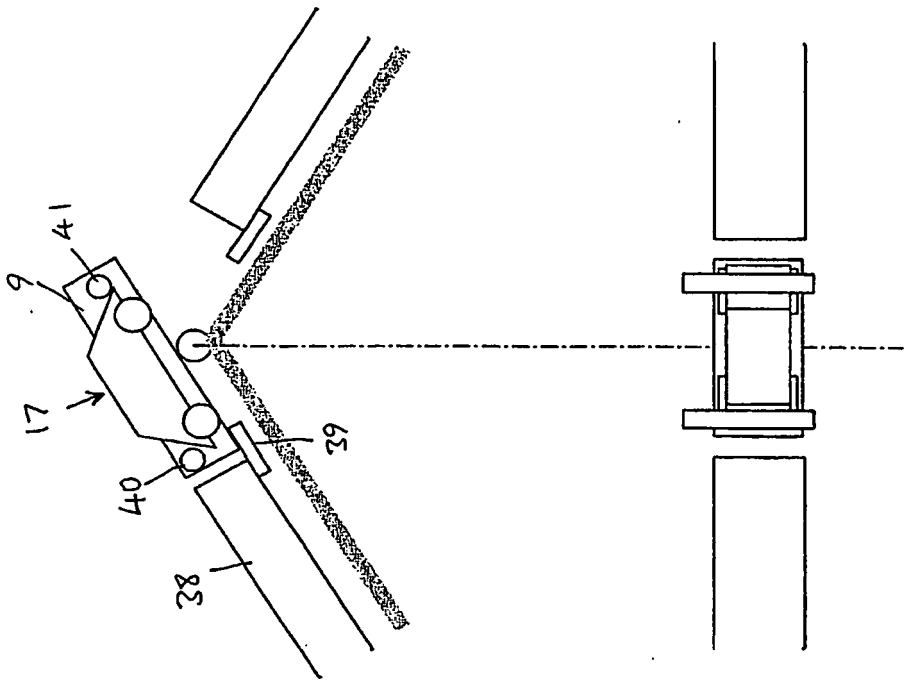


Fig. 12b

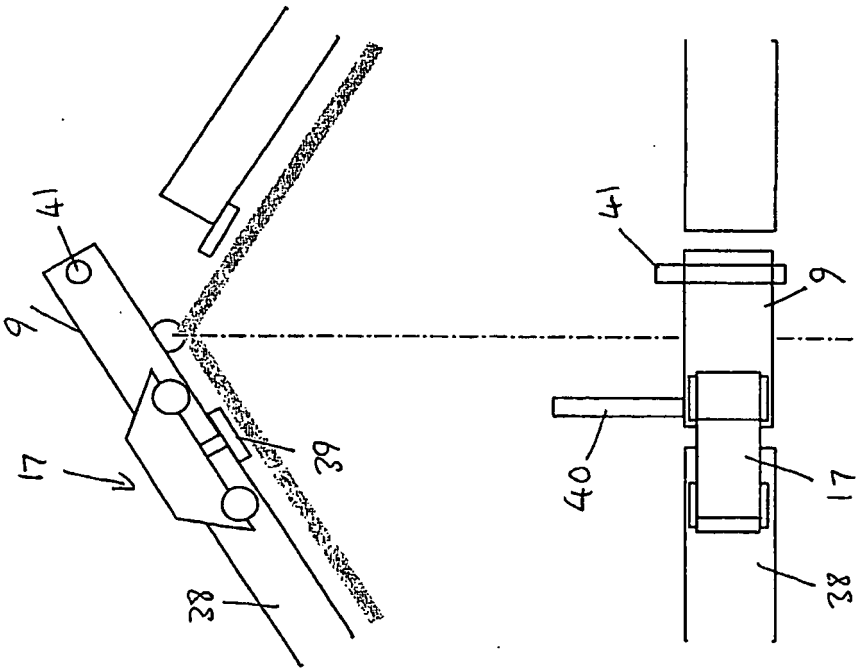


Fig. 12a

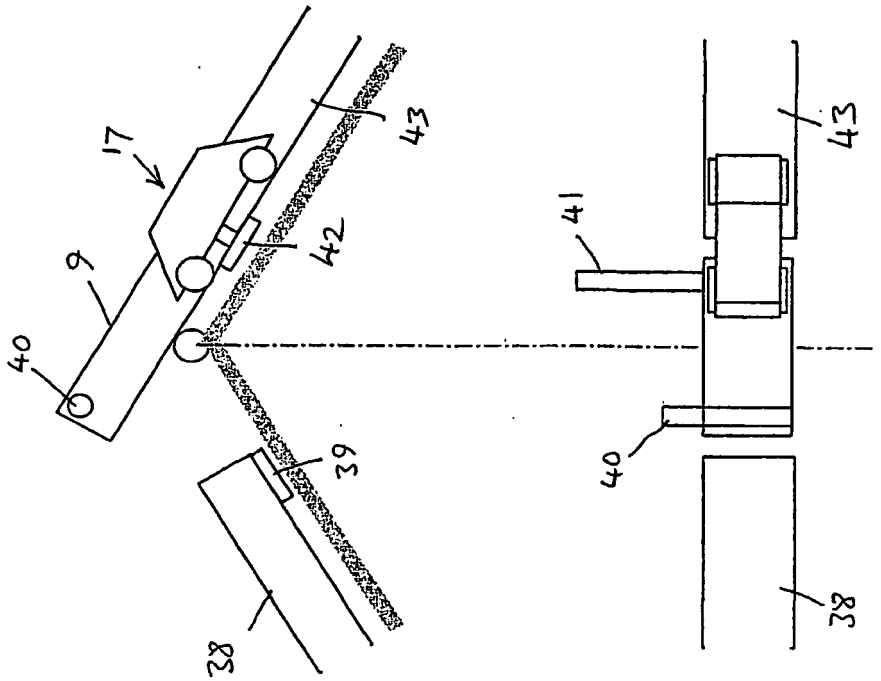


Fig. 13b

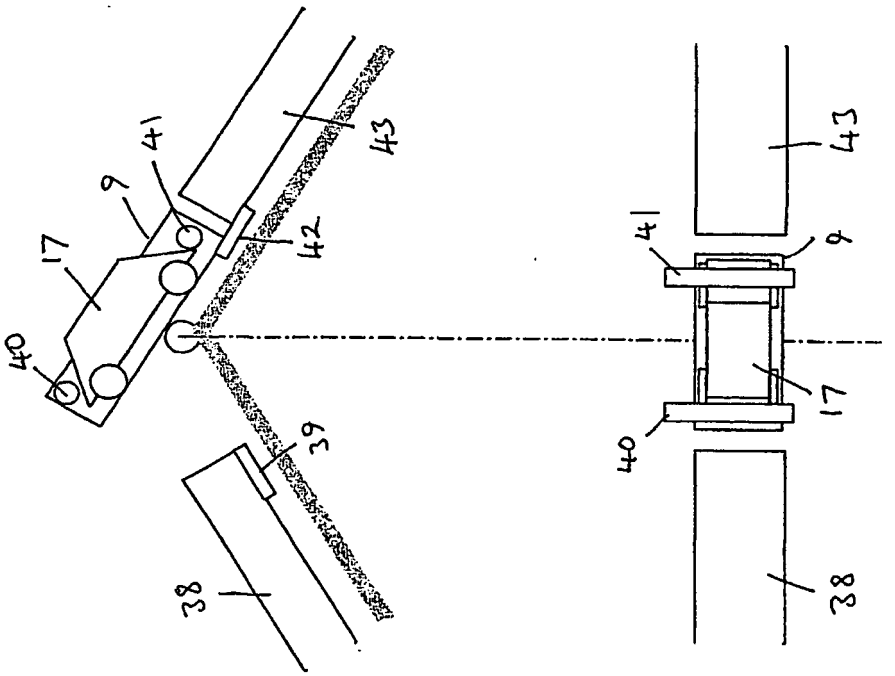


Fig. 13a

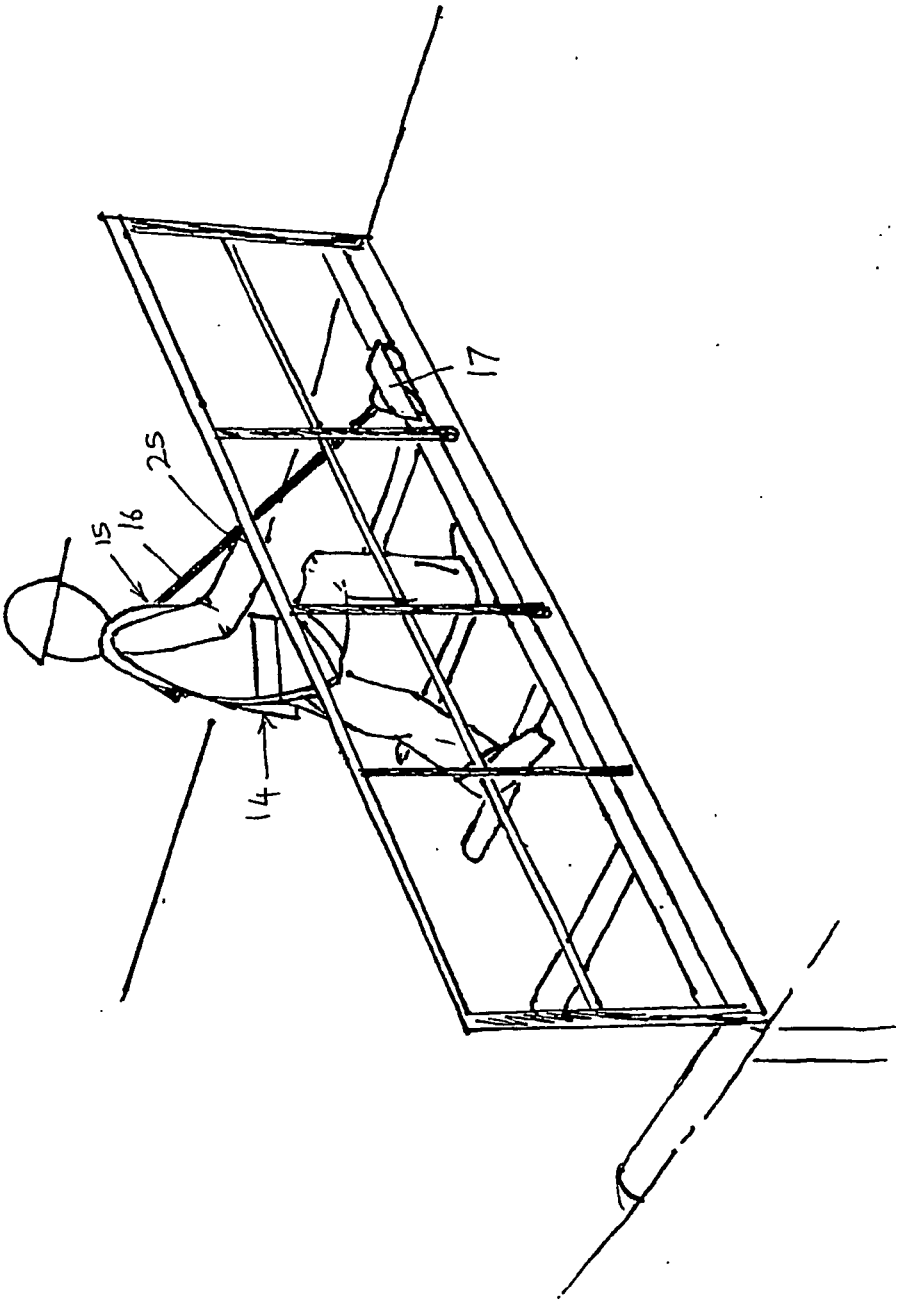


Fig 14