United States Patent [19]

Clark-Padwicki

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[45] **June 19, 1973**

[54] **ESCAPE DEVICE**

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[52] **U.S. Cl.** **182/6,** 182/192, 188/65.4

[51] **Int. Cl.** **A62b 1/14,** B65h 59/14

[58] **Field of Search** 182/5, 6, 7, 191, 182/192, 193; 188/65.4, 65.5

[56] **References Cited**

UNITED STATES PATENTS

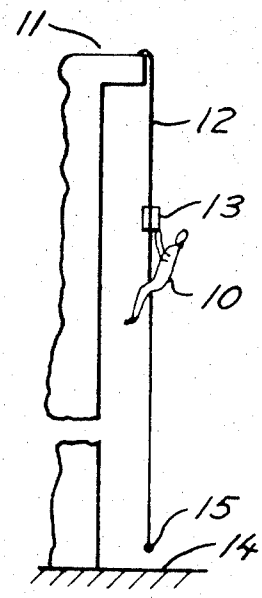
2,073,312	3/1937	Miller	182/7
649,073	5/1900	Racey	182/7
1,490,524	3/1924	Wood	182/7
311,039	1/1885	Scheidt et al.	182/5
456,532	7/1891	Bliss	182/192
481,923	9/1892	Badger	182/6
2,976,955	3/1961	Huber	182/192

Primary Examiner—Reinaldo P. Machado
Attorney—Brian J. Wood

[57] **ABSTRACT**

Device to effect controlled descent down a rope of an incapacitated person carried in a harness secured to the device. The device has a series of spaced grooved rollers on one side of the rope, the rollers being aligned in a plane containing the rope and staggered between opposing series of coplanar rollers, the rope following a sinusoidal path between both series of rollers. The rollers are coupled together to ensure equal peripheral speeds when device is moved relative to rope. Automatic brake responsive to descent speed brakes rollers to maintain predetermined descent speed. Gearing between rollers and brakes permits relatively light braking force to control a relatively heavy person. Number, size and spacing of rollers maintains sufficient arc of contact of rope on rollers to reduce slippage of rope when rollers are braked. Additional hand operated brake stops descent.

13 Claims, 13 Drawing Figures



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SHEET 1 OF 2

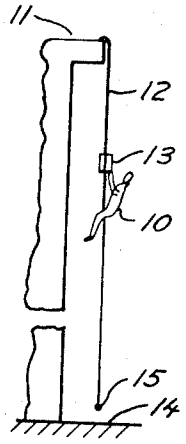


Fig. 1

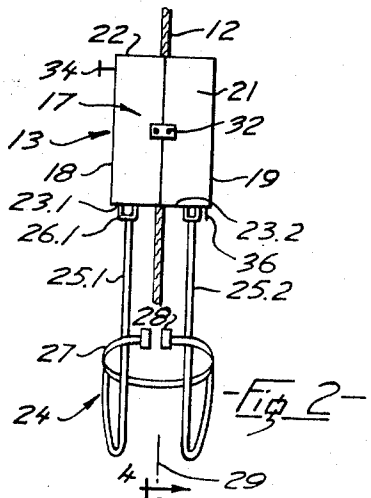


Fig 2

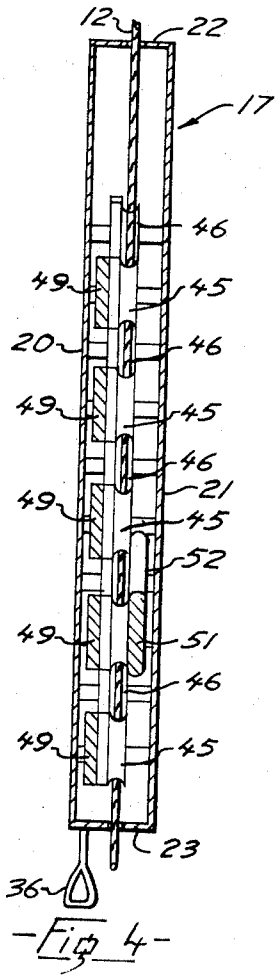


Fig 4

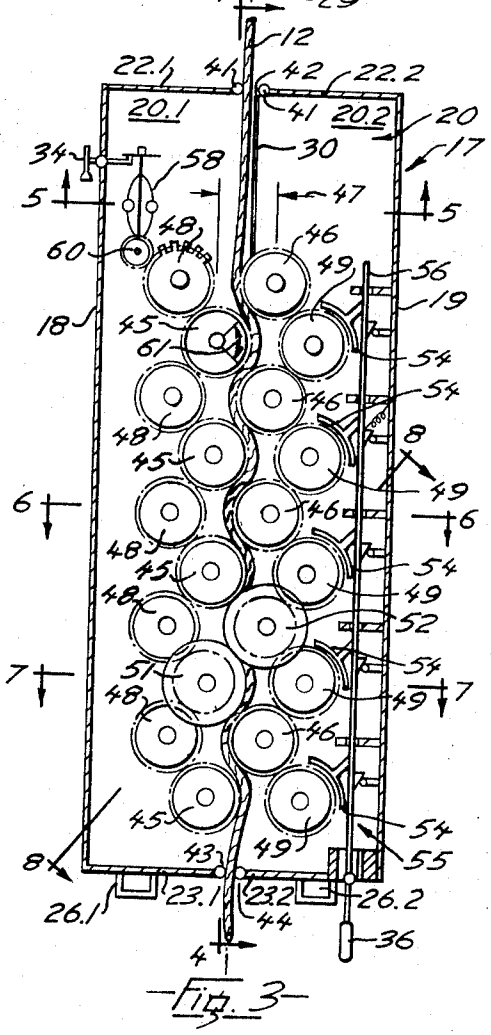
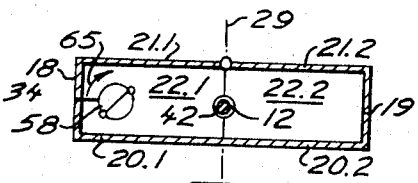
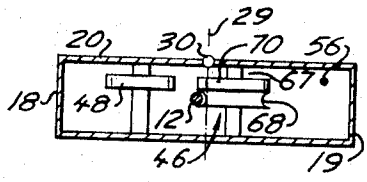


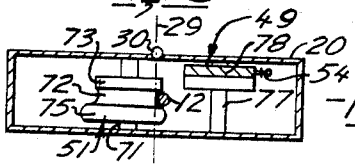
Fig. 3



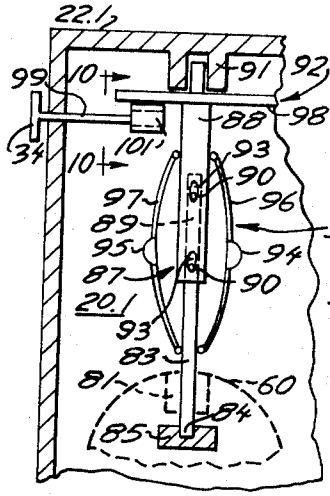
-Fig. 5-



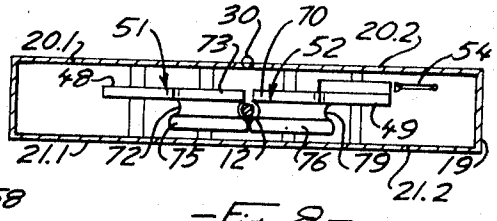
-Fig. 6-



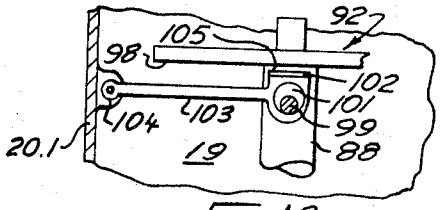
-Fig. 7-



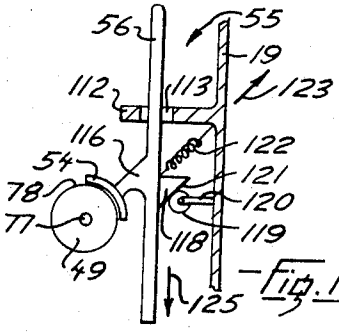
-Fig. 9-



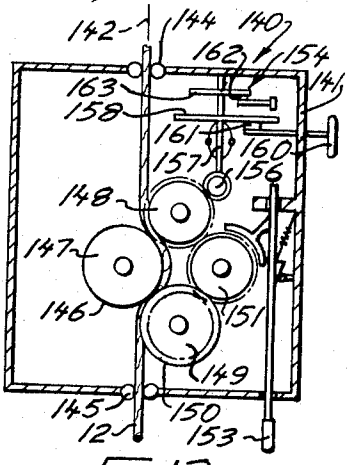
-Fig. 8-



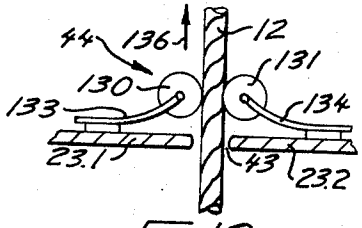
-Fig. 10-



-Fig. 11-



-Fig. 13-



-Fig. 12-

ESCAPE DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an escape device adapted to engage a rope frictionally, the device supporting a person descending the rope.

2. Prior Art

Escape devices adapted to engage a rope and to support a person escaping are known. Often these devices utilize friction braking means driven by rollers in engagement with the rope, braking being controlled by the person escaping. Sometimes in the confusion of escaping he lets go of the brake and is subsequently injured or killed due to a too rapid descent down the rope. Unconscious or otherwise incapacitated persons cannot use these devices as the brakes are operated by the person escaping.

SUMMARY OF THE INVENTION

The invention reduces difficulties above by providing an escape device that has an automatic brake that can be set at a particular rate of descent between a maximum and minimum speed. An additional manually operable brake can be included to stop the descent. The device can be set to lower an unconscious person, or a person otherwise incapacitated. Compensation is provided for weight differences of persons using the device.

One embodiment of the device includes a frame that journals a first series of rollers for rotation on a plane containing the rope, the rollers being aligned in spaced relationship on one side of the rope, each roller having a groove to accept the rope. A second roller or series of rollers, journalled for rotation in the plane containing the rope, are provided on a side of the rope remote from the first series of rollers and are staggered between the rollers so as to urge the rope into frictional engagement with the first rollers. The rollers are synchronized so as to have equal peripheral speeds, thus reducing a tendency of the rope to slip on the rollers. The rollers are coupled to a centrifugal brake having a braking disc, the disc being rotated by the rollers and being axially slidable to contact a brake block complementary to the disc. By selection of gearing between the rollers and the centrifugal brake, a relatively light braking force on the braking disc can support a relatively heavy person hanging from the device. A tensioning means maintains sufficient tension in the rope to remove kinks. Total arc of contact of the rope on the grooved rollers maintained by the complementary means produces negligible rope slippage in the rollers when the rollers are braked so that a controlled descent of the rope is attained.

A detailed description following, related to drawings, gives exemplification of apparatus according to the invention which apparatus, however, is capable of expression in structure other than that particularly described and illustrated.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a small scale diagram showing a person using an escape device according to the invention,

FIG. 2 is a front elevation of the device, showing a harness attached,

FIG. 3 is a front elevation, partially diagrammatic, similar to FIG. 2, the harness and some portions being removed to show interior construction,

FIG. 4 is a simplified section on 4—4 of FIG. 3, some portions being omitted, and some not being shown sectioned,

FIG. 5 is a simplified section on 5—5 of FIG. 3, some portions being omitted,

FIG. 6 is a simplified section on 6—6 of FIG. 3, some portions being omitted,

FIG. 7 is a simplified section on 7—7 of FIG. 3, some portions being omitted,

FIG. 8 is a simplified section on 8—8 of FIG. 3, some portions being omitted,

FIG. 9 is a simplified fragmented section of a portion of the device showing a centrifugal braking mechanism, some portions not shown in section,

FIG. 10 is a simplified section on 10—10 of FIG. 9, some parts omitted,

FIG. 11 is a simplified, fragmented section of a hand brake actuation mechanism,

FIG. 12 is a simplified section of rope tensioning rollers,

FIG. 13 is a simplified section of an alternative simplified escape device.

DETAILED DISCLOSURE

FIGS. 1 and 2

A person 10 escaping from a building 11 is shown descending a rope 12, for example a braided steel rope. The rope passes through an escape device 13 according to the invention, the device having a harness to carry the person, FIG. 2. The rope extends to a low end, two or three feet above the ground 14, a weight 15 hanging from the end tensions the rope to remove kinks in the rope.

With reference to FIG. 2, the device 13 has a structural frame (not shown) within a housing 17, the housing having left hand and right hand side walls 18 and 19, a rear wall 20 (see FIGS. 3 and 4), a front wall 21, and top and bottom walls 22 and 23. A harness 24 adapted to carry the person in a slightly inclined upright position as seen in FIG. 1, has main straps 25.1, 25.2 secured to releasable fasteners 26.1, 26.2 on the bottom wall 23. The straps 25.1, 25.2 are secured to a circumferential strap 27, ends of which are joined by a buckle 28. Loops at lower ends of the straps 25.1, 25.2 accept thighs of the person escaping, the strap 27 passing around the chest. Other harnesses are known and can be substituted.

A central longitudinal plane 29, appearing as a central axis in FIG. 2, bisects front rear top and bottom walls producing two halves of the housing. Each housing half has a corresponding divided wall, for example, the rear wall 20 has right and left divided walls 20.1 and 20.2 (FIG. 3), the front wall 21 has divided walls 21.1 and 21.2, the top wall 22 has divided walls 22.1 and 22.2, and similarly the bottom wall 23 has divided walls 23.1 and 23.2.

The rear divided walls 20.1 and 20.2 are hinged at 30 to permit the two halves of the housing to open or close, to permit easy engagement of the rope for threading. A latch 32 on the front wall holds the two halves together when the rope has been threaded as will be described. A hand wheel 34 extending from the side wall 18 provides a means of adjusting rate of descent to a particular speed, as is later described with refer-

ence to FIG. 9. A hand-operated brake has a handle 36 used to stop descent.

FIGS. 3 and 4

With reference to FIG. 3, the rope 12 passes through a slot 42 between the divided walls and the top wall 22, and through a slot 43 between the divided walls of the bottom wall 23. The rope passes freely through the slot 42, peripheral rollers 41 being provided for the rope to run on. The slot 43 has a tensioning roller assembly 44 straddling the rope, described with reference to FIG. 12.

Two series of grooved rollers engage the rope as shown, the rope passing between each series of rollers in a generally sinusoidal path. Hereinafter, and in the claims, vertical, left and right hand sides are as viewed in FIG. 3. Rollers on the left hand side of the rope are designated severally 45, and rollers on the right hand side are designated severally 46. The grooved rollers are journalled for rotation in a common plane, and are aligned in spaced vertical relationship on opposite sides of the rope, centre-to-centre distance measured normal to the plane 29 being designated 47 in FIG. 3, hereinafter roller row spacing. The grooved rollers are staggered as shown and are described in more detail with reference to FIGS. 6, 7, and 8.

The grooved rollers 45 and 46 have integral gear teeth which mesh with synchronizing gears 48 and 49 respectively, the gears meshing with and synchronizing adjacent grooved rollers so as to equalize surface speeds of grooves of adjacent rollers. The left hand side train of gears and rollers has a coupling roller 51 and the right hand side train has a coupling roller 52, peripheries of the rollers being engaged frictionally, so as to interconnect the left hand side train with the right hand side train, the coupling rollers serving as synchronizing means. Thus, peripheral groove speeds of the rollers 45 and 46 are equalized to reduce a tendency of the rope to slip on the rollers. The grooves are also surfaced with a material that has a high coefficient of friction when in contact with the rope 12, one example of such material being leather. Hereinafter, peripheral groove speed refers to mean tangential speed of the groove in contact with the rope. Gear ratios and relative diameters of grooves are selected as to maintain essentially equal peripheral groove speeds for all rollers in contact with the rope, thus tendency of the rope to slip on the rollers is reduced.

A plurality of brake shoes 54 of a hand brake 55 are adapted to engage braking surfaces of the gears 49, described with reference to FIGS. 7, 8, and 11. The brake shoes 54 are secured to and operated by a sliding brake rod 56 (FIG. 11), the rod being connected to the handle 36 which is used to operate the hand brake. Braking as above slows or stops rotation of the rollers 46, which, through the gears and coupling rollers, slows or stops the rotation of all the rollers, slowing or stopping motion of the device 13 relative to the rope.

A manually adjustable centrifugal brake 58 is provided at an upper end of the left hand side train of gears and rollers. The brake 58 is coupled to an adjacent grooved roller 45 by an idler gear 60 and a synchronizing gear 48. The brake is adjustable to a particular speed of descent by the hand wheel 34 and is later described with reference to FIG. 9.

A central concept of the invention is to maintain a relatively large arc of contact of the rope with the grooved roller, whilst providing a device that is relatively compact and easy to thread. The arc of contact of the rope with a particular roller 45 is designated 61, about ninety degrees. The total arc of contact for all the grooved rollers 45 is ninety degrees times the number of rollers. The total arc of contact of the grooved rollers 46 is similarly calculated. Thus, total arc of contact of the rope is proportional to the sum of the total arcs of contact. The relationship between the arc of contact and tensions on either side of a pulley is well known in the art of belt drives, and is expressed in the equation

$$\log_e (T_1/T_2) = \mu \theta$$

where T_1 and T_2 are tensions in the belt on either side of a pulley, μ is the coefficient of friction and θ is the arc of contact expressed in radians.

Other factors being constant, the greater the total arc of contact, the greater the work that can be absorbed from the rope without slippage between the rope and rollers. Arc of contact can be increased by one or both of two approaches. A first approach is to decrease the roller row spacing by increasing centre-to-centre distance between the rollers measured parallel to the axis, i.e. vertical spacing of rollers, thus permitting the rows of rollers 45 and 46 to move closer towards the longitudinal axis. The second approach is to increase the number of rollers. The two series of rollers are thus complementary to each other, serving to increase arc of contact. When considering the series of rollers 46, the rollers 45 are complementary means journalled for rotation within a common plane containing the rope and the rollers 46.

Closeness of rollers and vertical spacing of roller row spacing determines ease of closing the housing after threading the rope between the grooved rollers. Clearly, a stiff steel rope resists bending and difficulty can be experienced in bending the rope to close conformity with grooved rollers, which rollers have a diameter of about two inches.

Flexible braided steel rope of about 2,000 pounds ultimate tensile strength is used for the rope 12 and is relatively easy to handle and has resistance to fire damage.

FIGS. 5, 6, 7, and 8

Referring to FIG. 5, the centrifugal brake 58 rotates in a direction shown by an arrow 65. The brake can be adjusted, during descent if required, by the hand wheel 34 to attain a descent speed of between four and eight feet per second. The hand brake 55 (not shown in FIG. 5), controlled by the handle 36, is actuated to stop the escaper near the ground, and is not generally used during the descent.

Referring to FIG. 6, one grooved roller 46 of the right hand side train is journalled on a spindle 67, has an annular groove 68 in engagement with the rope 12, and has gear teeth 70 meshing with adjacent synchronizing gears 49 (not shown).

Referring to FIG. 7, the coupling roller 51 is journalled on a spindle 71, and has a groove 72 to accept the rope 12, and gear teeth 73 meshing with adjacent synchronizing gears 48 (not shown). The roller 51 has a tire 75 in frictional engagement with a corresponding tire of the roller 52, shown in FIG. 8. The gear teeth 73 mesh with the adjacent gears (not shown). The synchronizing gear 49, journalled for rotation on a spindle 77, is provided with a cylindrical braking surface 78 adapted to be engaged by the brake shoes 54, so as to

slow rotation of the gear **49** so as to slow rotation of the grooved rollers **45** and **46.** The braking surface can be provided on the grooved rollers instead of on the synchronzing gears. Position of the braking surface is immaterial provided that it is effectively coupled to the grooved rollers such that speed of rotation of braking surface is proportional to descent speed.

As seen in FIG. **8,** the rope **12** is held in grooves **72** and **79** of the rollers **51** and **52.** The tires **75** and **76** are in frictional engagement, synchronizing each train of rollers and gears.

FIGS. **9** and **10**

The centrifugal brake **58** is driven by gearing **81** (broken outline), which is driven by the idler **60** (broken outline). The gearing **81** drives a first shaft **83,** a lower end **84** of which is journalled for rotation in a bearing **85,** which bearing restricts the downward movement of the shaft **83.** The gearing **81** is any suitable known gearing that provides a step-up velocity ratio from the idler **60** to the shaft **83.** The gearing can be worm and worm wheel, bevel or any other type that has a sufficient velocity ratio to produce a rotational speed as later described.

The shaft **83** is aligned with a second shaft **88,** which shaft has a bore **89** at a lower end to accept the shaft **83** in a sliding fit, forming a telescoping drive shaft **87.** An upper end of the shaft **88** is journalled in a bearing **91,** which bearing permits vertical sliding movement of the shaft **88.** Radial pins **90** extend outwards from the shaft **83** and engage longitudinal slots **93** in the shaft **88,** permitting longitudinal sliding motion of the shaft **88** relative to the shaft **83,** whilst preventing relative rotation of the shafts.

Centrifugal fly weights **94** and **95** are secured to flexible spring strips **96** and **97,** upper ends of which strips are secured to the shaft **88,** and lower ends are secured to the shaft **83.** Rotation of the shaft **83** causes the fly weights **94** and **95** to move outwards, the shaft **88** being pulled downwards relative to the shaft **83** due to outward movement of the strips **96** and **97.** Pinned links or other members can be substituted for the flexible strips.

A braking disc **92** is secured to the shaft **88,** a lower surface **98** of the disc serving as a braking surface. The hand wheel **34** is secured to a shaft **99** journalled in the side wall **18.** An inner end of the shaft **99** has a cylindrical lobe **101** mounted eccentrically relative to the shaft, as a cam.

With reference to FIG. **10** a brake block **102** serving as a complementary braking member is provided at an outer end of an arm **103,** an inner end **104** of the arm being hinged to a portion of the rear wall **20.1** permitting rotation of the arm. An upper surface **105** of the brake block **102** serves as a complementary brake surface and is adapted to contact the lower surface **98** of the disc. The block **102** has a bore which accepts the lob **101** in a sliding fit. Rotation of the shaft **99** by the wheel **34** moves the surface **105** upwards or downwards, which determines the position of the disc at which braking commences, which position limits downward movement of the disc.

When the upper surface **105** is separated from the surface **98,** acceleration down the rope increases speed of rotation of the shaft **88,** the centrifugal weights moving outwards and forcing the disc downward until the surface **98** contacts the upper surface **105.** Braking of the disc occurs, which braking slows rotation of the grooved rollers **45** and **46,** thus reducing speed of descent, which reduction in speed slows the shaft **88,** permitting the fly weights to move inward, easing brake pressure between the brake and the surface **98,** thus increasing speed of descent. Successive damped oscillations of speed of descent about an average speed of descent rapidly diminish, permitting attainment of a steady speed. Rotation of the hand wheel **34** such that the upper surface **105** attains a second position further remote from the surface **98,** permits attainment of a higher rmp before contact of the disc with the brake surface.

Thus the centrifugal brake is a brake responsive to speed of descent down the rope, and can be set to operate between maximum and minimum descent speeds. Additional parameters which determine speed of descent include rope stiffness, rope hysteresis loss, rope tension, energy losses due to friction in the gear train, and weight of person descending. A scale (not shown) can be provided on the hand wheel **34** to be read in conjunction with a pointer (not shown), the scale being calibrated to a person's weight and desired speed of descent, so that, prior to starting the descent, compensation for weight can be made.

A further central concept of the invention is thus use of a relatively small braking force on the brake disc to control a relatively large force suspended from the device. Such control is attained by a mechanical advantage arising from the gearing between the grooved rollers **45** and **46** and the braking disc **92.** For a descent speed of four to eight feet per second, the disc **92** is geared to rotate at a speed of between 1,500 and 3,000 rpm. The frictional losses in the gear train, particularly at the gearing **81** if a worm and worm wheel is used, account for a proportion of the energy to be absorbed, remainder being absorbed at the brake.

FIG. **11**

A portion of the hand brake **55** is shown, in which the brake rod **56** is slidably mounted in a bracket **112,** the bracket having an elongated slot **113** to accept the rod **56,** and to permit limited lateral movement of the rod. The bracket **112** extends from the side wall **19** at a position adjacent each synchronizing gear **49** so as to provide support for the rod **56** against excessive movement. The brake shoe **54** engages the braking surface **78** of the gear **49** and is secured to the rod **56** by an arm **116.** A cam **118,** secured to the rod **56,** is in engagement with a roller **119** journalled on a bracket **120,** the bracket **120** being secured to the side wall **19.** The cam **118** has a working surface **121** inclined to the rod at such an angle as to move the brake shoe **54** essentially radially against the braking surface of the gear **49** when the rod **56** is moved in a direction shown by an arrow **125.** Thus the roller **119** serves as a cam follower secured relative to the frame, the cam working surface moving in response to movement of the rod **56.** A tension spring **122** extends between the rod **56** and the side wall **19,** providing a force generally in the direction of an arrow **123,** tending to release the brake shoe **54** from engagement with the braking surface **78.** Thus the spring **122** has an axis essentially parallel to the working surface of the cam **118.**

FIG. **12**

The rope **12** passes through the slot **43** between the divided walls **23.1** and **23.2** as previously described. The tensioning roller assembly **44** straddles the rope **12** as shown, and has rollers **130** and **131** made from a hard resilient substance. The rollers are journalled at

upper ends of spring-urged arms **133** and **134**, lower ends of the arms being secured to the divided walls **23.1** and **23.2**. The rollers are urged inwards and downwards so as to squeeze the rope as it passes upwards in a direction shown by an arrow **136**. The rollers are mounted so as to tend to swing away from the rope as the device descends, thus applying a limited tension. Thus the rollers are not adapted to grip the rope tighter as the rope runs in direction of the arrow **136** — this is in contrast to a wedge-action device. The rollers serve as tensioning means, being sufficient to apply a relatively low tension on the rope so as to tend to straighten a portion of the rope prior to that portion passing through the device. Such tensioning reduces a tendency to slippage of the rope on the grooved rollers.

ALTERNATIVES AND EQUIVALENTS

Other means of rope tensioning are known, such as a second person pulling the rope at the lower end, or use of the relatively light weight **15** on the lower end of the rope, as shown in FIG. **1**. If the tensioning rollers are provided and the rope extends freely downwards, its own weight can provide sufficient tension thus eliminating the weight **15**. However, with such a rope as the low end of the rope is approached, tension is reduced and speed of descent tends to increase. If the tensioning rollers are not provided then, use of light ropes may not provide sufficient tension without the weight **15**.

With reference to FIG. **3**, the left hand and right hand trains of rollers and gears are synchronized by the coupling rollers **51** and **52**. Other means of synchronization are known, such as a duplicate centrifugal brake for the right hand side similar to the brake **58**. When two centrifugal brakes are used, both brakes are actuated together to ensure essentially equal braking on each side to reduce differences in peripheral speeds on either side of the rope. Hereinafter such means to ensure essentially equal braking on each side is referred to as means to attain synchronized braking of the rollers.

If one train of gears only is braked, e.g. by elimination of the coupling rollers **51** and **52**, braking effectiveness is reduced. Also, the hand brake **55** can be eliminated if the rate of descent is sufficiently slow to ensure safe landing when the device is controlled only by the centrifugal brake. Elimination of the hand brake prevents a panic stricken person from locking the device on the rope, as the centrifugal brake cannot be set below a minimum rate of descent. Simple stop means (not shown) can be provided to make the hand brake inoperative.

Other types of descent speed responsive brakes can be used, such as a centrifugal brake in which weights on bellcranks move radially outwards as speed increases, extending a rotating braking disc against a stationary complementary braking component. Also the braking surface **78** for the brake shoes can be provided on the grooved roller, instead of on the synchronizing gears **49**. In either case the braking surface rotates with or is coupled to the grooved rollers.

FIG. **13**

An alternative simplified device **140** is provided with fewer grooved rollers to produce a more compact device, three rollers being a minimum.

The alternative device **140** has a housing **141**, having a longitudinal central plane **142**. The rope **12** passes through slots **144** and **145** and follows a curved path (as shown). The left hand side of the casing has a grooved roller **147**, journalled for rotation and staggered between similar grooved rollers **148** and **149** on the right hand side of the case. The roller **147** has a tire **146** adapted to mesh with a tire **150** of the roller **149**, thus synchronizing peripheral speeds of both rollers and serving as a complementary means journalled for rotation within a common plane containing the rope and the rollers **148** and **149**. The rollers **148** and **149** have gear teeth meshing with a synchronizing gear **151**. The gear **151** has a braking surface similar to the surface **78** of the gear **49**, and is braked by a hand-operated brake **153** similar to the brake **55** (see FIG. **11**). A centrifugal brake **154** is coupled to the gear of the grooved roller **148** through an idler gear **156**, the centrifugal brake having a telescoping drive shaft **157** and a disc **158**. A hand wheel **160** controls a lobe **161**, similar to the brake **58** of FIG. **9**. A similar disc **163** and a lobe **162** is preset before use and can be used to apply extra braking if required, setting a maximum speed of descent. Operation of the centrifugal brake **154** is similar to that of the brake **58**, being a braking means responsive to speed of descent.

It should be noted that compared to the device **13**, (FIG. **3** etc.) fewer grooved rollers are used in the device **140**. This reduces total arc of contact of the rope on the rollers which, other factors being equal, increases tendency of the rope to slip on the grooved rollers. Thus, it may be preferable to use a stiffer rope with the alternative device, or to use a tensioning means which applies a greater tension. Alternatively, the device should be limited to use by relatively light persons only, thus requiring less braking effort.

The grooved roller **147** serves as a complementary means to urge the rope against the synchronized rollers **148** and **149**, all three rollers being simultaneously braked because of coupling between, and synchronization of, the rollers. Other means complementary to the grooved rollers and adapted to urge the rope onto the grooved rollers can be substituted. As with the device **13**, the hand brake **153** can be eliminated if, with the centrifugal brake alone, speed of descent is sufficiently slow.

OPERATION

To descend a rope hanging generally vertically under tension, the person opens the device by unhooking the latch **32** and engages between the rollers a portion of the rope approximately level with himself. He then closes the device with the latch, ensuring that the rope is guided cleanly through the slots and is aligned with the grooves of the roller. The rope is clamped between adjacent opposing pairs of grooved rollers, being in effect threaded in a sinusoidal passage existing between the rollers, thus locking the device onto the rope. The person then climbs into the harness, adjusting where necessary to obtain a good fit, as in a parachute harness. He takes the hand brake handle **36** in one hand, but does not actuate it unless he is required to stop. He steps off into space and is carried by the harness which hangs below the device as seen in FIG. **1**. Speed of descent down the rope is increased or decreased between limits by adjusting the handwheel **34** of the centrifugal brake. Near the ground the hand brake **55** is applied to stop the descent.

When the person escaping reaches the ground, he unclips from the harness, disengages the device from the

rope, and leaves the rope for others escaping using additional escape devices.

I claim:

1. A device adapted to carry a person for effecting a controlled descent of a rope hanging generally vertically, the device including:

a. a frame adapted to accept a portion of the rope extending therethrough and to journal rollers,

b. a harness secured to the frame and adapted to carry the person,

c. at least one pair of grooved rollers journalled for rotation within a common plane containing the rope, the rollers being aligned in spaced relationship on one side of the rope, each roller having a groove to accept the rope,

d. synchronizing means essentially to equalize peripheral groove speeds of each roller,

e. complementary means journalled for rotation within the common plane containing the rope, the complementary means being on a side of the rope remote from the grooved rollers and staggered between the rollers so as to urge the rope into frictional engagement in the grooves of the rollers to provide a total arc of contact of the rope with the roller, the total arc of contact being sufficient to reduce a tendency of the rope to slip on the rollers,

f. tensioning means to tension the rope,

g. a centrifugal brake responsive to speed of descent to brake the rollers against rotation, the brake having:

i. a telescoping drive shaft having first and second shafts slidable axially relative to each other and mounted for rotation, a braking disc having a braking surface and being secured to the first shaft, the second shaft being coupled to the grooved rollers,

ii. members connecting the upper and lower shafts, centrifugal fly weights being mounted on the members, the weights moving outwards and sliding the first and second shafts axially as the drive shaft is rotated,

iii. a braking member complementary to and spaced from the braking surface when speed of descent is below preset speed, so that increase of speed of descent increases speed of rotation of the telescoping shaft of the centrifugal brake, causing the braking surface of the disc to contact the complementary braking member and to slow rotation of the disc which slowing, with negligible rope slippage, slows speed of descent down the rope.

2. A device as defined in claim 1 in which the frame has:

i. a longitudinal axis passing through upper and lower ends, the axis being within a longitudinal plane, the frame being divided about the longitudinal plane into left hand and right hand portions, the portions being hinged together about vertical edges so as to permit the frame to open and close to permit the rollers to enclose the rope in frictional engagement, and slots provided at the upper and lower ends of the frame to guide and provide clearance for the rope.

3. A device as defined in claim 1 in which:

i. the complementary means are coupled to a roller so as to have a peripheral speed equal to that of the rollers, thus equalizing speeds on both sides of the rope so as to increase braking effectiveness.

4. A device as defined in claim 1 in which the complementary means includes:

i. a roller having a groove adapted to accept the rope, the roller being of such a diameter relative to spacing and diameters of the grooved rollers so that, when staggered between the grooved rollers on a side of the rope remote from the grooved rollers, the complementary means is complementary to the grooved rollers forming a passage for the rope between the rollers, and an arc of contact of the rope on the rollers is maintained so as to reduce a tendency of the rope to slip.

5. A device as defined in claim 11 in which the synchronizing means includes:

i. spur gear teeth concentric with and adjacent the groove of the grooved rollers,

ii. a synchronizing gear journalled for rotation and meshing with the gear teeth of the grooved rollers,

constructed and arranged so that peripheral groove speeds of the grooved rollers are essentially equal.

6. A device as defined in claim 1, wherein:

i. the grooved rollers are coupled to a braking surface,

and the device further includes a hand brake having:

ii. a brake shoe adapted to be forced against the braking surface so as to slow rotation of the grooved rollers.

7. A device as defined in claim 1 in which the tensioning means includes:

i. journalled rollers straddling the rope and mounted on spring-urged arms so as to tend to swing away from the rope as the device descends the rope and to squeeze the rope and restrain the rope against movement through the tensioning means, thus applying a limited tension to the rope.

8. A device as defined in claim 1, in which the braking member has:

i. a brake block having a braking surface adapted to contact the braking disc, the block having a bore,

ii. an arm having inner and outer ends, the inner end being hinged to the frame, the outer end being secured to the brake block,

iii. a cylindrical lobe fitted in the bore of the brake block and free to rotate,

iv. a shaft journalled in the frame having inner and outer ends, a handwheel secured to the outer end of the shaft and the cylindrical lobe secured eccentrically to the inner end of the shaft as a cam,

constructed and arranged so that rotation of the handwheel swings the arm and moves the brake block relative to the braking disc, controlling speed of the disc by braking arising from axial movement of the disc.

9. A device as claimed in claim 6, in which the hand brake includes:

i. a bracket secured to the frame, the bracket having an elongated slot,

ii. a brake rod slidably mounted in the elongated slot, the slot permitting axial sliding and limited lateral movement of the rod, the rod having a cam with a working surface inclined to the rod,

iii. a cam follower secured relative to the frame and in engagement with the working surface of the cam,

iv. the brake shoe is secured to the brake rod and positioned adjacent the braking surface coupled to

the grooved roller, the braking surface being cylindrical,

v. a spring extending between the rod and the frame to urge the brake shoe away from the braking surface,

so that when the person moves the braking rod axially, the cam surface is urged by the cam follower, simultaneously moving the rod laterally to force the brake shoe against the cylindrical braking surface, and when the rod is released the spring releases the shoe from the cylindrical braking surface.

10. A device as claimed in claim **9**, in which:

i. the cam follower is a roller journalled for rotation relative to the frame, the roller being in engagement with the working surface of the cam.

11. A device as claimed in claim **9**, wherein:

i. the working surface of the cam is inclined at such an angle as to move the brake shoe essentially radially relative to the braking surface.

12. A device as claimed in claim **1**, wherein:

i. the members connecting the upper and lower shafts are flexible strips.

13. A device adapted to carry a person for effecting a controlled descent on a rope hanging generally vertically, the device including:

i. a frame adapted to accept a portion of the rope extending therethrough and to journal rollers,

ii. a harness secured to the frame and adapted to carry the person,

iii. a first series of grooved rollers journalled for rotation within a common plane containing the rope, the rollers being aligned in spaced relationship on one side of the rope, each roller having a groove to accept the rope,

iv. a similar opposing second series of aligned grooved rollers staggered relative to, and closely spaced from, the first series of rollers, grooves of each pair of opposing rollers being aligned so as to form a passage to accept the rope between staggered pairs of rollers so as to provide a suitable total arc of contact of the rope with the rollers, the total arc of contact being sufficient to reduce a tendency of the rope to slip on the rollers,

v. synchronizing means essentially to equalize peripheral groove speeds of each series of rollers,

vi. tensioning means to tension the rope,

vii. a centrifugal brake responsive to speed of descent to brake the rollers against rotation, the brake having:

i. a telescoping drive shaft having first and second shafts slidable axially relative to each other and mounted for rotation, a braking disc having a braking surface and being secured to the first shaft, the second shaft being coupled to the grooved rollers,

ii. members connecting the upper and lower shafts, centrifugal fly weights being mounted on the members, the weights moving outwardly and sliding the first and second shafts axially as the drive shaft is rotated,

iii. a braking member complementary to and spaced from the braking surface when speed of descent is below preset speed, so that increase of speed of descent increases speed of rotation of the telescoping shaft of the centrifugal brake, causing the braking surface of the disc to contact the complementary braking member and to slow rotation of the disc which slowing, with negligible rope slippage, slows speed of descent down the rope.

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