

ROPE GRAB

BACKGROUND

[0001] Regulations typically require workers who work at heights to don a safety harness that is coupled to a support structure so that if a fall event occurs, the fall is limited, therein reducing the chances of injuries to the worker. Systems that protect workers during fall events that can occur while climbing or descending on structures such as ladders and the like can be a challenge because of the varying vertical locations of the worker in relation to a support structure.

[0002] For the reasons stated above and for other reasons stated below which will become apparent to those skilled in the art upon reading and understanding the present specification, there is a need in the art for an effective and efficient rope grab system that includes a rope grab and a generally vertically placed elongated member that is used as a support structure.

SUMMARY OF INVENTION

[0003] The above-mentioned problems of current systems are addressed by embodiments of the present invention and will be understood by reading and studying the following specification. The following summary is made by way of example and not by way of limitation. It is merely provided to aid the reader in understanding some of the aspects of the invention.

[0004] In one embodiment, a rope grab is provided. The rope grab includes a housing, a locking cam, a cam biasing member and a locking arm. The housing has an elongated member guide forming an elongated member passage. The elongated member passage is configured and arranged to receive an elongated member. The locking cam is pivotally coupled to the housing. The locking cam is configured and arranged to selectively engage an elongated member received in the elongated member passage. The cam biasing member positioned to provide a relatively slight biasing force on the locking cam towards an elongated member received in the elongated member passage. The locking arm is pivotally coupled to the housing. The locking arm has a first end that is configured and arranged to be coupled to a safety harness of a user and a second end that is configured and arranged to selectively engage the locking cam to lock the locking cam on an elongated member in the elongated member passage during a fall event.

[0005] In another embodiment, another rope grab is provided. The rope grab of this embodiment includes a housing, a locking cam and a locking arm. The housing has an elongated member guide that forms an elongated member passage. The elongated member passage is configured and arranged to receive an elongated member. The locking cam is pivotally coupled to the housing. The locking cam is configured and arranged to selectively engage an elongated member received in the elongated member passage. The locking cam has a radial edge that is configured and arranged to engage the elongated member. The radial edge having a curvature that varies in relation to a pivot connection to the housing so that the radial edge engages each elongated member at a contact angle that is the same even when different diameter elongated members are received in the elongated member passage of the housing. The locking arm is pivotally coupled to the housing. The locking arm has a first end that is configured and arranged to be coupled to a safety harness of a user and a second end that is configured and arranged to selectively engage the locking cam to lock the locking cam on an elongated member during a fall event.

[0006] In another embodiment, yet another rope grab system is provided. The rope grab system includes at least one bypass bracket and a rope grab. The at least one bypass bracket is configured and arranged to couple an elongated member to a support structure. The rope grab includes a housing, a locking cam, and a cam spring. The housing has an elongated member guide that forms an elongated member passage. The elongated member passage is configured and arranged to pass an elongated member and a portion of the at least one bypass bracket there through. The locking cam is pivotally coupled to the housing. The locking cam is configured and arranged to selectively engage one of the elongated member and the portion of the at least one bypass bracket. The cam spring is coupled between the housing and the locking cam to provide a relatively slight biasing force on the locking cam towards the elongated member and the portion of the at least one bracket received in the elongated member passage. The relatively slight biasing force is countered by gravity during normal operations of the rope grab.

[0007] In still further another embodiment, a method of manipulating a rope grab is provided. The method includes rotating a lever rotationally coupled to a housing to release a rotating side plate with a hand of a user; pulling back on an end of the rotating side plate to pivot a portion of the rotating side plate away from a side opening to an elongated member passage formed in the housing with the hand of the user; positioning the rope grab to receive an elongated member within the elongated member passage of the housing with the hand of the

user; and releasing the rotating side plate to allow the rotating side plate to at least partially cover the side opening to the elongated member passage of the housing to retain the elongated member with the elongated member passage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The present invention can be more easily understood and further advantages and uses thereof will be more readily apparent, when considered in view of the detailed description and the following figures in which:

[0009] Figure 1 is a side perspective view of a rope grab of one embodiment of the present invention;

[0010] Figure 2 is an unassembled view of the rope grab of Figure 1;

[0011] Figure 3A is a first side view of a housing of the rope grab of Figure 1 of one embodiment of the present invention;

[0012] Figure 3B is a cross-sectional front view of the housing along line 3B-3B of Figure 3A;

[0013] Figure 3C is a second side view of a housing of the rope grab of Figure 1;

[0014] Figure 3D is a top view of the housing of the rope grab of Figure 1;

[0015] Figure 4A is a side view of a fixed side plate of one embodiment of the rope grab of Figure 1;

[0016] Figure 4B is a front view of the fixed side plate of Figure 4A;

[0017] Figure 5A is a side view of a rotating side plate of one embodiment of the rope grab of Figure 1;

[0018] Figure 5B is a front view of the rotating side plate of Figure 5A;

[0019] Figure 6A is a side perspective view of an arm spring of one embodiment of the rope grab of Figure 1;

[0020] Figure 6B is a side view of the arm spring of Figure 6A;

[0021] Figure 6C is a top view of the arm spring of Figure 6A;

[0022] Figure 7A is a side perspective view of a spring spacer of one embodiment of the rope grab of Figure 1;

- [0023] Figure 7B is a side view of the spring spacer of Figure 7A;
- [0024] Figure 7C is a cross-sectional front view of the spring spacer along line 7C-7C of Figure 7B;
- [0025] Figure 8A is a side perspective view of a first lever of one embodiment of the rope grab of Figure 1;
- [0026] Figure 8B is a front view of the first lever of Figure 8A;
- [0027] Figure 9A is a side perspective view of a locking member of one embodiment of the rope grab of Figure 1;
- [0028] Figure 9B is a first side view of the locking member of Figure 9A;
- [0029] Figure 9C is a second side view of the locking member of Figure 9A;
- [0030] Figure 10A is a side view of a locking arm of one embodiment of the rope grab of Figure 1 with the rotating side plate in a locked position;
- [0031] Figure 10B is a side view of the locking arm of Figure 10A with the rotating side plate in an unlocked position;
- [0032] Figure 11A is a side perspective view of a locking cam of one embodiment of the rope grab of Figure 1;
- [0033] Figure 11B is another side perspective view of the locking cam of Figure 11A;
- [0034] Figure 11C is a side view of the locking cam of Figure 11A;
- [0035] Figure 11D is a second side view of the locking cam of Figure 11A;
- [0036] Figure 11E is a front view of the locking cam of Figure 11A;
- [0037] Figure 12A is a cross-sectional side view of a partial rope grab of Figure 1 engaging a first elongated member of a first diameter;
- [0038] Figure 12B is another cross-sectional side view of a partial rope grab of Figure 1 engaging a second elongated member of a second diameter;
- [0039] Figure 13A is a partial side view of a locking cam of one embodiment;
- [0040] Figure 13B is a close up view of a portion of a profile of a radial edge of the locking cam of Figure 13A;
- [0041] Figure 14A is a side perspective view of an assembled bypass bracket of one embodiment of the present invention;

- [0042] Figure 14B is a side unassembled view of the bypass bracket of Figure 14A;
- [0043] Figure 15A is a side perspective view of a bypass bracket of an embodiment of the present invention coupled to a support structure and a rope grab;
- [0044] Figure 15B is a side perspective view of the bypass bracket of Figure 15A;
- [0045] Figure 15C is a top view of the bypass bracket of Figure 15A coupled to the support structure;
- [0046] Figure 16A is a first side perspective view of a rope grab of another embodiment of the present invention;
- [0047] Figure 16B is a second side perspective view of the rope grab of Figure 16A;
- [0048] Figure 16C is a rear perspective view of the rope grab of Figure 16A;
- [0049] Figure 17 is an unassembled side view of the rope grab of Figure 16A;
- [0050] Figure 18A is a side view of a locking arm of the rope grab of Figure 16A with a rotating side plate in a locked position;
- [0051] Figure 18B is a side view of the locking arm of the rope grab of Figure 16A with the rotating side plate in an unlocked position;
- [0052] Figure 19A is a cross-sectional side view of a partial rope grab of Figure 16A engaging a first elongated member of a first diameter;
- [0053] Figure 19B is another cross-sectional side view of a partial rope grab of Figure 16A engaging a second elongated member of a second diameter;
- [0054] Figure 20A is a first side perspective view of a rope grab of yet another embodiment of the present invention;
- [0055] Figure 20B is a second side perspective view of the rope grab of Figure 20A;
- [0056] Figure 21 is an unassembled side view of the rope grab of Figure 20A;
- [0057] Figure 22A is a side view of a locking arm of the rope grab of Figure 20A with a rotating side plate in a locked position;
- [0058] Figure 22B is a side view of the locking arm of the rope grab of Figure 20A with the rotating side plate in an unlocked position;
- [0059] Figure 23A is a cross-sectional side view of a partial rope grab of Figure 20A engaging a first elongated member of a first diameter; and

[0060] Figure 23B is another cross-sectional side view of a partial rope grab of Figure 20A engaging a second elongated member of a second diameter.

[0061] In accordance with common practice, the various described features are not drawn to scale but are drawn to emphasize specific features relevant to the present invention. Reference characters denote like elements throughout Figures and text.

DETAILED DESCRIPTION

[0062] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in which the inventions may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the spirit and scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the claims and equivalents thereof.

[0063] Embodiments of the present invention provide a rope grab (cable grab) used for fall protection that can be easily manipulated with one hand to attach and detach the rope grab from an elongated member such as a rope, cable or the like used as a support structure. Embodiments of the rope grabs 100, 1000 and 2000 described herein are designed to be coupled to a safety harness donned by a user and to lock onto an elongated member during a fall event to limit the fall of the user. An embodiment of the rope grab 100 is illustrated in the side perspective view of Figure 1 and the exploded view of the rope grab 100 in Figure 2. The rope grab 100 includes a housing 200, a locking cam 300, a locking arm 400, a rotating side plate 500, and a fixed side plate 600. The locking cam 300, the locking arm 400 and the rotating side plate 500 are pivotally coupled to the housing 200 as further discussed below. The elements of the rope grab 100 are first described and then the construction and operation of the rope grab 100 are described.

[0064] The housing 200 of the rope grab 100 is further illustrated in Figures 3A through 3D. The housing 200 includes a body 202 that has a first side 303a and a second side 303b. The body 202 further has an upper end 202a and an opposed lower end 202b. Proximate the upper end 202a of the body 200 is positioned an upper end wall portion 201a that extends generally perpendicular from the first side 303a of the body 202. Proximate the lower end 202b of the body 202 is positioned a lower end wall portion 201b that extends generally

perpendicular from the first side 303a of the body 202. The body 202 further has a first side edge 202c and an opposed second side edge 202d. Proximate the first side edge 202c of the housing 200 is a cable guide 231 that extends from the first side 303a of the body 202 in generally a C shape. The cable guide 231 forms a cable guide passage 230 (or elongated member passage) that extends from proximate the upper end 202a to the lower end 202b of the body 202. Proximate the lower end 202b of the body 202 of the housing 200 and proximate the first side 202c of the body 202 of the housing 200 is positioned a lower roller rivet passage 240 that passes through the body 202. Moreover, a central post 204 extends generally perpendicular from the first side 303a of the body 202. The central post 204 is generally located at a mid-portion between the upper end 202a and the lower end 202b of the body 202 towards the second side edge 202d of the body 202 of the housing 200. The central post 204 includes a first central post portion 204a, a second central post portion 204b and third central post portion 204c. The first central post portion extends from the first side 303a of the body 202. The second central post portion 204b extends from the first central post portion 204a and has a diameter that is less than a diameter of the first central post portion 204a. The third central post portion 204c extends from the second central post portion 204b and has a diameter that is less than the diameter of the second central post portion 204b. A central post passage 206 passes through the central post 204. Surrounding the central post 204 is a cam spring holding channel 218 that is formed in the first side 303a of the body 202. The cam holding channel 218 includes a circular portion 218a and an extending leg portion 218b. In the embodiment shown, the leg portion 218b terminates in a spring retaining aperture 218c.

[0065] A lever passage 212 passes through the body 202 of the housing 200 proximate the second side edge 202d and towards the lower end 202b of the body 202. The lever passage 212 is further positioned proximate the central post 204. The lever passage 212 includes a circular portion 212a and an extending portion 212b that extends from the circular portion 212a towards the lower end 202b of the body 202 of the housing 200. Proximate the lever passage 212 is a side wall portion 214 that extends generally perpendicular from the first side 303a of the body 202 of the housing 200. The side wall portion 214 is further generally positioned between the central post 204 and the lever passage 212. Proximate the side wall portion 214 is a mid-wall portion 216 that also generally extends perpendicular from the first side 303a of the body 202 of the housing 200. The mid wall portion 216 is also positioned proximate the lever passage 212. Further, a raised portion 215 extends from the first side 303a of the body 202 of the housing 200. The raised portion 215 extends from the first side 303a of the body 202

around the lever passage 212. The height of the raised portion 215 is less than a height of the side wall portion 214 and a height of the mid wall portion 216. The housing 200 further includes a lower post 208 that is positioned proximate the lower end 202b of the body 202 of the housing 200. The lower post 208 extends from the first side 303a of the body 202 and includes a central lower post passage 210. In particular, the lower post 208 includes a first lower post portion 208a that extends from the first side 303a of the body 202 and a second lower post portion 208b that extends from the first lower post portion 208a. The second lower post portion 208b has a diameter that is less than a diameter of the first lower post portion 208a. The housing 200 also has an upper post 221 that extends from the first side 303a of the body 202. The upper post 221 is positioned proximate the upper end 202a of the body 202 and includes an upper post passage 220. As illustrated in Figure 3C, a lever spring holding channel 211 is formed in the second side 303b of the body 202 of the housing 200 around a portion of the lever passage 212. Also illustrated in Figure 3C is a lever stop 233 that extends from the second side 303b of the body 202 of the housing 200 proximate the lever passage 212. The lever stop 233 is designed to stop rotation of lever 700 at a select orientation.

[0066] The fixed side plate 600 is illustrated in Figures 4A and 4B. The fixed side plate includes an upper end 612 and an opposed lower end 614. The fixed side plate 600 further includes a first edge 616 and an opposed second edge 618. The fixed side plate 600 further includes a first side 602a and a second side 602b. A first connecting passage 606 passes through the fixed side plate 600 proximate the upper end 612 and the first edge 616. A second connection passage 608 passes through the fixed side plate 600 proximate the first edge 616 and the lower end 614. The fixed side plate 600 further includes a third connection passage 604 which is positioned generally at a mid-portion of the fixed side plate 600 and towards the second edge 618. As illustrated in Figures 4A and 4B, a spring spacer bulge 602c extends from the first side 602a of the fixed side plate 600 creating a depression in the second side 602b of the fixed side plate 600 to receive an end of the spring spacer 112 as discussed further below. The third connection passage 604 is centrally located within the spring bulge 602c of the fixed side plate 600. The fixed side plate 600 also includes a lever passage 610 that is positioned proximate the second edge 618 of the fixed side plate 600 and between the third connection passage 604 and the lower end 614 of the fixed side plate 600. As illustrated in Figure 4A, the second side edge 614, in this embodiment, has several edge extending portions that extend at select angles from each other so that the second side edge 614 conforms to the general shape of the second side edge 202d of the housing 200.

[0067] Referring to Figures 5A and 5B, a rotating side plate 500 of one embodiment is illustrated. The rotating side plate 500 includes a first edge 508 and an opposed second edge 510. The rotating side plate 500 also includes an upper end 506 and an opposed lower end 504. The first edge 508 includes a plurality of edge portions 508a, 508b, 508c and 508d. In particular, the first portion 508a extends from the lower end 504 to the second portion 508b. The second portion 508b extends from the first portion 508a at a select angle. A third portion 508c extends from the second portion 508b at a select angle. The first, second and third portions 508a, 508b and 508c form a portion of the rotating side plate 500 that selectively blocks access to the cable guide passage 230 of the housing 200 as discussed further below. A fourth portion 508d extends from the third portion 508c to the upper end 506. The fourth portion 508d is generally curved forming generally a cutout section in the rotating side plate 500 that is designed to selectively receive the upper post 221 of the housing 200 when assembled. The second side edge 510 also has a plurality of edge portions 510a, 510b, 510c, 510d, 510e, 510f and 510g. In particular a first portion 510a extends from the lower end 504. A second portion 510b extends from the first portion 510a. A third portion 510c extends from the second portion 510b. A fourth portion 510d extends from the third portion 510c and a fifth portion 510e extends from the fourth portion 510d. As illustrated in Figure 5A the third portion 510c, fourth portion 510d and the fifth portion 510e form a cutout section in the second edge 510 of the rotating side plate 500 that allows for movement of the rotating side plate 500 in relation to the spring spacer 112 when the rope grab 100 is assembled. The sixth portion 510f extends from the fifth portion 510e at a select angle. The seventh portion 510g extends between the sixth portion 510f and the upper end 506. The rotating side plate 500 further includes a first side surface 502a and a second side surface 502b. Proximate the lower end 504 and extending in a direction of the second side surface 502b of the rotating side plate is an extending tab 502c. The rotating side plate 500 further includes a pivot connection passage 512 positioned proximate the lower end 504 and a roller connection passage 514 positioned proximate the upper end 506.

[0068] Figures 6A through 6C illustrate an arm spring 110 of one embodiment. The arm spring 110 includes a central coiled portion 110a. The coiled portion 110a is positioned between a first end portion 110b and a second end portion 110c. The first end portion 110b extends inward in relation to the coiled portion 110a. The second end portion 110c extends in a direction away from the first end portion 110b and terminates in a bent holding end 111. The second end portion 110c of the arm spring 110 is shaped to engage an arm spring groove 409

of the locking arm 400 as discussed further below. Figures 7A through 7C illustrate a spring spacer 112 of one embodiment of the present invention. The spring spacer 112 includes generally a cylindrical body 112a having a first end 113 and an opposed second end 114. The body 112a of the spring spacer 112 further includes a central passage 115. In addition, a spring holding slot 112b is formed in the first end 113 of the spring spacer 112. The spring holding slot 112b extends across the first end 113 of the spring spacer 112 such that it extends into a portion of the central passage 115. Moreover, the spring holding slot 112b is designed to receive the first end portion 110b of the arm spring 110 while the coiled portion 110a of the arm spring 110 is positioned around the cylindrical body 112a of the spring spacer 112. The spring spacer 112 further includes a bore 112c extending into the first end 113 of the cylindrical body 112a. The bore is used by a tool to put a required pre-wind on the arm spring 110 during assembly.

[0069] Figures 8A through 8B illustrate a first lever 700 of one embodiment of the present invention. The first lever 700 includes a stem 702 and an activation knob 704. The stem 702 includes a first stem portion 702a and a second stem portion 702b. The first stem portion 702a extends between the activation knob 704 and the second stem portion 702b. The second stem portion 702b has a diameter that is less than the diameter of the first stem portion 702a. An engaging tab 710 centrally extends from a surface of the first stem portion 702a. A pair of rotating locking tabs 708a and 708b opposably extend from a surface of the second stem portion 702b proximate the first stem portion 702a. The activation knob 704 includes a first disk portion 704a which is coupled to an end of the first stem portion 702a and a second extending portion 704b which extends away from the first disk portion 704a in a select direction. The second extending portion 704b provides leverage to rotate the stem 702. The activation knob 704 further has a third extending portion 704c that extends from the second extending portion 704b towards the stem portion 702. The third extending portion 704c is designed to selectively engage the lever stop 231 on the second side 303b of the housing 200 when assembled. Figures 9A through 9C illustrate a lock member 106 of one embodiment. The lock member 106 includes a cylindrical base member 106a and an extending portion 106d that extends away from the cylindrical base member 106a proximate an end of the cylindrical base member 106a. The lock member 106 has a first side 107 and an opposed second side 109. The cylindrical base member 106a includes a lock member passage 106c and a cutout section 106b that is positioned proximate the first side 107 of the lock member 106. Extending portion 106d includes a lock spring holding channel 106e that is formed in the second side 109 of the

locking member 106. The lock spring holding channel 106e extends across the width of the extending portion 106d. The extending portion 106d further includes a lock spring holding slot 106f in a side of the extending portion 106d that extends a height of the extending portion 106d. The lock spring holding slot 106f extends into the lock spring holding channel 106e.

[0070] Illustrations of the locking arm 400 are provided at least in Figures 2, 10A and 10B. The locking arm 400 includes a locking arm main portion 402 and a locking arm energy absorber portion 404. The locking arm main portion 402 includes a main locking arm passage 412. In addition, a locking arm extending portion 408 extends from the locking arm main portion 402 in a direction that is opposite a direction that the locking arm energy absorber portion 404 extends from the locking arm main portion 402. An arm spring groove 409 is formed in an edge proximate a junction between the locking arm main portion 402 and the locking arm energy absorber 404. The locking arm energy absorber portion 404 includes an energy absorber connector passage 406 proximate a termination end of the locking arm energy absorber portion 404. The energy absorber connection passage 406 is used to connect a safety harness (not shown) donned by a user to the rope grab 100 as further discussed below. For example, in a typical application, a frontal D-ring of a safety harness would be coupled to the swivel connector 122 attached to the energy absorber portion 404 of the locking arm 400 via carabiner (not shown). During a fall event, the locking arm energy absorber portion 404 is designed to straighten out therein absorbing energy to prevent injuries to the user.

[0071] Referring to Figures 11A through 11E one embodiment of a locking cam 300 is illustrated. The locking cam 300 includes a cam body 302. The cam body 302 of the locking cam 300 includes a connection portion 302a and an engagement portion 302b. The cam body 302 further includes a first side 301a and a second side 301b. The connection portion 302a of the cam body 302 includes a cam passage 304. Proximate the cam passage 304 in the connection portion 302a of the locking cam 300 is a cam spring holding portion 306 which includes a cam spring passage 306b which extends through the locking cam 300 and a cam spring slot 306a which is formed in the first side 301a of the cam body 302. The cam spring slot 306a leads to the cam spring passage 306b. In use, a portion of a cam spring 132 (a cam biasing member) illustrated in Figure 2 is received in the cam whole spring holding portion 306 as further described below. The first side 301a of the cam body 302 further includes a recessed portion 312 that is positioned proximate the cam spring holding portion 306 and extending to an edge of the cam body 302. The recessed portion 312 provides room for movement of the holding end 111 of the second end portion 110c of the arm spring 110

engaging the locking arm 400 when the rope grab is assembled. The engaging portion 302b of the locking cam 300 extends from the connection portion 302a. The width of the engaging portion 302b is greater than the width of the connection portion 302a. In particular, the width of the engaging portion 302b extends wider than the width of the connection portion 302a in the direction of the first side 301a of the cam body 302. The engaging portion 302b of the locking cam 300 further terminates in a radial edge 302c. The radial edge 302c extends generally radially about cam passage 304 with a varied radial configuration as described below. The radial edge 302c has generally a concave surface with a plurality of extending gripping tabs 310 that are designed to frictionally engage an elongated member.

[0072] The engaging portion 302b of the locking cam 300 further includes a first side edge 320 and a second side edge 321 that respectively extend from the connection portion 302a to the radial edge 302c. The second side edge 321 extends generally in a straight line from the connection portion 302a to the radial edge 302c. The first side edge 320 has a plurality of first side edge portions 320a, 320b and 320c. The first side edge portion 320a extends from the connection portion 302a in generally a perpendicular fashion. The second side edge portion 320b extends from the first side edge portion 320a in generally a curved configuration. The third side edge portions 320c extends from the second side edge portion 320b in generally a straight line to the radial edge 302c. The locking cam 300 further includes a hub portion 303 that extends around the cam passage 304 of the connection portion 302a of the cam body 302. The hub 303 extends out from the second side 301b of the cam body 302. The engaging portion 302b of the locking cam 300 further includes a third edge 330 that defines the engaging portion 302b from the connection portion 302a. The third edge 330 includes a locking arm engaging surface 332. The extending portion 408 of the locking arm 400 engages the locking arm engaging surface 332 of the locking cam 300 during a fall event as the locking arm 400 as further discussed below.

[0073] The construction of the rope grab 100 is further described in view of Figure 2 and the Figures described above. A cam spring 132 having a coiled section 132a and a first end 132b is received in the cam spring holding channel 218 of the body 202 of the housing 200. In particular, the coiled section 132a of the cam spring 132 is received in the circular portion 218a of the cam spring holding channel 218 and the first end 132b of the cam spring 132 is received in the leg portion 218b of the cam spring holding channel 218. This configuration retains a first end of the cam spring 132 in a static configuration in relation to the housing 200. A first bearing 128 is positioned within the cam passage 304 of the locking cam 300. The cam

passage 304 is then positioned around the first post portion 204a of the central post 204 of the housing 200. A second end 132c of the cam spring 132 is passed through the cam spring passage 306b and received in the cam spring slot 306a of the cam spring holding portion 306 of the locking cam 300. This arrangement of the cam spring 132 provides a relatively light biasing force on the locking cam 300 to rotate the locking cam 300 towards an elongated member in the elongated member passage 230 of the housing 200. This relatively light biasing force is countered by gravity in normal climbing operations which keeps the cam lock 300 from locking onto the elongated member. Hence during normal operations, the rope grab 100 moves relatively freely up and down the elongated member. In a free fall (fall event), gravitational forces do not counteract the light biasing force of the cam spring 132 and the locking cam 300 will lock onto the elongated member. Inertial loads on the locking cam 300 during a fall also work in tandem with the light biasing force of the cam spring 132 to rotate the locking cam 300 onto the elongated member.

[0074] A second bearing 126 is positioned in the main locking arm passage 412 of the locking arm 400. The main locking passage 412 of the locking arm is then positioned around the second post portion 204b of the central post 204 of the housing 200. The spring spacer 112 is then positioned around the third post portion 204c of the central post 204. The coiled portion 110a of the arm spring 110 is positioned around the spring spacer 112 while the first end portion 110b of the arm spring 110 is received in the spring holding slot 112b of the spring spacer 112. The first end portion 110b of the arm spring 110 is further received in the cut out section 203 of the third post portion 204c of the post 204 of the housing 200. This arrangement holds the first end portion 110b of the arm spring 110 in a static position in relation to the housing 200. The second end portion 110c of the arm spring 110 is received in the arm spring groove 409 of the locking arm 400 to assert a biasing force on the locking arm 400 in a locked position. A fastener, such as rivet 142 passing through the central post passage 206 of the central post 204 of the housing 200 and the third connector passage 604 of the fixed side plate 600 couples the housing 200 to the fixed side plate 600.

[0075] A lever spring 138 is positioned over the stem 702 of the first lever 700. The stem 702 of the first lever 700 is in turn passed through the lever passage 212 of the housing 200. A first end portion 138a of the lever spring 138 is received in a spring holding bore 705 in the first lever 700. A second end portion 138b of the lever spring 138 is positioned in a gap in the second side edge 214 of the housing 200 so that a biasing force is exerted on the stem 702 of the first lever 700 in a desired direction. The extending portion 212b of the lever passage 212

allows the engaging tab 710 (shown in Figure 8A) extending from the stem 702 of the first lever 700 to pass through the lever passage 212. Once the stem 702 is passed through the lever passage 212 of the housing 200, the lock spring 108 is positioned around the stem 702. A first end portion 108a of the lock spring 108 engages a portion of the second side wall 214 of the housing 200 to hold the first end portion 108a of the lock spring 108 in a static location in relation to the housing 200. The stem 702 of the first lever 700 is then passed through the lock member passage 106c of the lock member 106. The engaging tab 710 of the stem 702 of the first lever 700 is received in the cut out section 106b of the lock member 106 to lock the rotation of the stem 702 with the rotation of the lock member 106. A second end portion 108b of the lock spring 108 is received in the lock spring holding channel 106e of the extending portion 106d of the lock member 106 to exert a biasing force on the lock member 106 in a desired direction. The stem 702 is then further passed through the lever passage 610 in the fixed side plate 600. A washer 104 and a second lever 102 are then coupled on the second stem portion 702b of the stem 702. The second lever 102 includes a stem connection passage 102c with opposed grooves 102a and 102b. The opposed grooves 102a and 102b respectfully receive the rotation locking tabs 708a and 708b of the stem 702 of the first lever 700 to lock rotation of the second lever 102 to the rotation of the stem 702.

[0076] A first fastener 140 (first rivet) passing through the upper post passage 220 of the upper post 221 of the housing 200 and through the first connection passage 606 in the fixed side plate 600 and a second fastener 144 (second rivet) passing through the lower post passage 210 of the lower post 208 of the housing 200 and through the second connection passage 608 in the fixed side plate 600 further couples the housing 200 to the fixed side plate 600. The second fastener 144 further passes through the pivot connection passage 512 of the rotating side plate 500 to provide a pivot connection for the rotating side plate 500. The rope grab 100 further includes an upper roller 114 and a lower roller 134 to guide the elongated member through the cable guide channel 230 of the housing 200. The upper roller 114 is rotationally coupled to the rotating side plate 500 via upper roller rivet 116. The lower roller 134 is rotationally coupled to the housing 200 adjacent the cable guide 231 of the housing 200 via lower rivet 136.

[0077] A lifeline swivel connector 122 is coupled to the energy absorbing portion 404 of the locking arm 400 via swivel pivot connector 118. In particular, the swivel lifeline connector 122 includes a base 121c with a connection passage 121 and a pair of spaced arms 122a and 122b with aligned passages 123a and 123b. A pair of spaced arms 118a and 118b of a swivel

pivot connection 118 is passed through the connection passage 121 of the swivel lifeline connector 122. A head portion 118c of the swivel pivot connection 118 has a diameter larger than the diameter of the connection passage 121 of the swivel lifeline connector 122. The pair of spaced arms 118a and 118b have aligned swivel pivot connection passages 117. A rivet 120 passes through the aligned swivel pivot connection passages 117 and the connection passage 406 of the locking arm 400 to couple the swivel lifeline connector 122 to the locking arm 400. A rivet 124 passed through the aligned passages 123a and 123b of the swivel lifeline connector 122 is used to couple a lifeline to the rope grab 100. As discussed above, the lifeline would be coupled to a safety harness (not shown) donned by a user.

[0078] Referring to the partial views of the rope grab 100 in Figures 10A and 10B the operation of the rope grab 100 is discussed. Figure 10A illustrates the rotating side plate 500 in a retaining configuration in which a portion of the rotating side plate 500 proximate the first edge 508 of the rotating side plate 500 covers at least a portion of the side opening 150 to the cable guide passage 230. In this configuration, an elongated member (not shown in Figure 10A) is retained in the cable guide passage 230 of the cable guide 231 of the housing 200. The retaining configuration is achieved when the extending portion 106d of the lock member 106 engages the second edge portion 510b of the second edge 510 of the rotating side plate 500 which retains the rotating side plate 500 in a static location in relation to the cable guide 231. The lock spring 108 biases the lock member 106 in this configuration. Figure 10B illustrates the rotating side plate 500 in an open configuration. In this configuration, a portion of the rotating side plate 500 proximate the first edge 508 of the rotating side plate 500 is moved far enough away from the cable guide 231 to allow passage of an elongated member into and out of the cable guide passage 230 through the side opening 150 to the cable guide passage 230. To get the rotating side plate 500 into this configuration, at least one of the first and second levers 700 and 102 is rotated, which rotates the extending portion 106d of the lock member 106 away from the second edge portion 510b of the second edge 510 of the rotating side plate 500. The biasing force from the side plate spring 130 engaging the extending tab 502c biases the rotating side plate 500 to the retaining configuration. Hence, the rotating side plate 500 must be rotated by hand after at least one of the levers 700 or 102 is rotated. This is done by pulling back on the rotating side plate 500 proximate the upper roller 114. The rope grab 100 is designed so that a user can both rotate one of the levers 700 or 102 and pull back on the rotating side plate 500 to put the rotating side plate in the open configuration with a single hand. Once in the open position, an elongated member can be slid into or out of the cable

passage 230. Once the elongated member is positioned in or taken out of the cable passage 230, the rotating side plate 500 can be released to rotate the rotating side plate 500 to the retaining position and the lever 700 or 102 can be released to engage the lock member 106 to the rotating side plate 500.

[0079] The partial cross-sectional side views of the rope grab 100 of Figure 12A and 12B illustrate the rope grab 100 engaging two different elongated members 702 and 714 respectfully. As discussed above, the elongated members 702 and 714 may be a rope, a cable or any type of elongated member that can be used as a safety support member. One of the features of embodiments of the present invention is that the elongated members 702 and 714 may have different diameters, as illustrated in Figures 12A and 12B, but will have the same contact angle 720 (α_1 and α_2). That is, the curvature of the radial edge 302c of the locking cam 300 is not constant in relation to the central post passage 206. The curvature varies so that the same contact angle 720 between the radial edge 302c of the locking cam 300 and the cable guide 231 of the housing is achieved for a range of diameters of the elongated members. The contact angle 720 is an angle that provides sufficient holding friction of the rope grab 100 between the radial edge 302c of the locking cam 300 and the cable guide 231 during a fall event. This is further discussed below.

[0080] The partial cross-sectional views in Figures 12A and 12B illustrate the rope grab 100 in use after the elongated member 702 or 714 has been positioned within the cable guide passage 230 of the housing 200. As illustrated, the elongated members 702 or 714 are guided through the cable guide passage 230 formed by the cable guide 231 with the upper roller 114 and the lower roller 134. During normal use when the user is climbing or descending, the locking cam rotates to the open position under the influence of gravity, so a minimal (if any) frictional force is applied to the elongated member via the rope grab 100. Hence, the rope grab 100, in a normal non-fall event use, is relatively free to move up and down on the elongated member with the movement of the user who would be coupled to the locking arm via carabiner or other connecting means and safety harness (not shown). Figures 12A and 12B illustrate that in this embodiment during normal use, a portion of the mid-side wall portion 216 of the body 202 of the housing 200 rests in the locking arm engaging groove 410 of the locking arm 400.

[0081] During a fall event, a user's frontal attachment to the user's harness that is coupled to the swivel connector 122 (which is in turn coupled to the locking arm 400) will pull the locking arm 400 down, therein rotating locking arm 400 about the central post 204. This movement causes the extending portion 408 of the locking arm 400 to engage the locking arm

engaging surface 332 of the locking cam 300 therein pivoting the locking cam 300 also about the central post 204 of the housing 200. This movement of the locking cam 300 forces the radial edge 302c of the locking cam 300 to forcefully pinch a portion of the elongated member 702 or 714 between the radial edge 302c of the locking cam 300 and the cable guide 231 of the housing 200 therein locking movement of the rope grab 100 in relation to the elongated member 702 or 714. If the force is great enough during the fall event, the energy absorber portion 404 of the locking arm 400 will straighten out to absorb energy and prevent injury to the user. The rope grab 100 will remain locked onto the elongated member 702 or 714 until the downward force of the fallen user is removed. As discussed above, also during a fall event, the gravitation forces on the cam lock 300 are overcome by the light biasing force of the cam spring 132 as well as by inertial forces, to also cause the cam lock 300 to lock onto the elongated members 702 or 714.

[0082] Referring to Figures 13A and 13B an explanation of achieving the same contact angle 720 with different sized elongated members 702 and 714 in one embodiment is provided. The profile of the radial edge 302c of the locking cam 300 for a given contact angle 720 (Alpha 1 and Alpha 2 in Figures 12A and 12B) is determined by dividing the locking cam 300 into multiple thin slices separated by planes 350 that are perpendicular to the profile of the radial edge 302c and pass through a rotational axis 360 of the locking cam 300. The profile of the radial edge 302c is generated by creating edges 352 that maintain an angle 354 (Beta) between the profile of the radial edge 302c of the locking cam 300 and the planes 350 separating the thin slices of the locking cam 300. Angle Beta 354 is equal to $90^\circ - \text{contact angle } 720$ (Alpha 1 or Alpha 2).

[0083] Embodiments of the present invention further includes a bypass bracket 800 that is designed to be coupled to a support structure and to hold an elongated member that the rope grab 100 is engaging in a generally static position. An example of a bypass bracket 800 is illustrated in Figures 14A and 14B. The bypass bracket 800 includes a base bracket 802. The base bracket 802 includes a first section 802a and a second section 802b. The second section 802b generally extends from the first section 802a in a perpendicular fashion. The first section 802a includes two spaced connection apertures 806a and 806b. The second section 802b of the base bracket 802 includes a first connection aperture 804a and a second connection aperture 804b. The bypass bracket 800 further includes a clamp member 810. This embodiment of the clamp member 810 is made from a plate that has a first side edge 810a and an opposably positioned second side edge 810b. The clamp member 810 further includes a top edge 810c and

an opposably positioned bottom edge 810d. The clamp member 810 further includes a centrally positioned upper connection aperture 812 that is positioned proximate the upper edge 810c of the clamp member 810. The clamp member 810 also includes a slot 814 that extends in the first side edge 810a of the clamp member 810 proximate the lower edge 810d of the clamp member 810. In use, a support structure such as, but not limited to, a rung of a ladder is positioned between the first section 802a of the base bracket 802 and the clamp member 810. A fastener 816a then passes through a connection aperture 806a in the base bracket 802 and the upper connection aperture 812 of the clamp plate member 810. A nut 818a is then threadably engaged to the fastener 816a to couple an upper portion of the clamp member 810 to the base bracket 802. Similarly, a fastener 816b is passed through a connection aperture 806b of the base bracket 802 and within slot 814 of clamp member 810. Nut 818b is then threadably engaged to the fastener 816b to couple a lower portion of the clamp member 810 to the base bracket 802.

[0084] The bypass bracket 800 further includes a sleeve clip 820. The sleeve clip 820 includes a first portion 820a that has first and second connection apertures 823 (only one connection aperture 823 is shown in Figure 14B). The connection apertures 823 are aligned with the first and second connection apertures 804a and 804b of the base bracket 802. Rivets 824a and 824b passing through the respective connection apertures 823, 804a and 804b couple the sleeve clip 820 to the base bracket 802. The sleeve clip 820 further includes a second portion 820b that extends from the first portion 820a in generally a perpendicular fashion. The second portion 820b includes holding ears 822a and 822b. The ears 822a and 822b are spaced by a central spaced portion 825. The first holding ear 822a has a generally C-shaped configuration with its open side facing a first direction. The second holding ear 822b is also in generally a C-shaped configuration with its open side facing a second direction that is generally opposite the first direction. The ears 822a and 822b form a receiving sleeve channel 821 that is formed from a first channel 821a formed by the first holding ear 822a and a second channel 821b formed by the second holding ear 822b.

[0085] A sleeve 830 is used in conjunction with the bypass bracket 800. The sleeve 830 has a tubular configuration with a central passage 832. An elongated member (such as elongated member 920 shown in Figure 15A) is received within the central passage. The sleeve 830 further includes a first recess section 831a and a second recessed section 831b. The first and second recess sections 831a and 831b are recessed into an outer surface of the sleeve 830 in an opposable fashion. The first and second recessed sections 831a and 831b are spaced

from each other by a mid-portion 830a of the sleeve 830. In particular, the first recess portion 831a is configured to receive the first holding ear 822a of the sleeve clip 820 and the second recessed portion 831b is configured to receive the second holding ear 822b of the sleeve clip 820. In use, once the bypass bracket 800 is coupled to the support structure as described above, the sleeve 830 (having the elongated member 920 passing through its central passage 832) is tilted in relation to the receiving sleeve channel 821 (approximately 90 degrees) and positioned such that the mid-portion of the sleeve 830 is received in the space 825 between the holding ears 822a and 822b of the sleeve clip 820. Once the mid-portion of the sleeve 830 is positioned within the space 825 between the holding ears 822a and 822b of the sleeve clip 820, the sleeve 830 is tilted to align with the receiving sleeve channel 821 of the sleeve clip 820, therein allowing the first ear 822a of the sleeve clip 820 to be received in the first recess 831a of the sleeve and the second holding ear 822b to be received in the second recess 831b of the sleeve 830. This locks the sleeve 830 within the sleeve clip 820 of the bypass bracket 800. This design allows the bypass brackets 800 to be attached to support structures prior to the connection to the elongated member 920.

[0086] The bypass bracket 800 is designed to hold the elongated member 920 stationary while not interfering with the function of the rope grab 100. Referring to Figures 15A through 15C an illustration of this is provided. The bypass bracket 800 in this embodiment, includes a clamp member 811 that has an edge with teeth 811a that are designed to grip the support structure 900. Figures 15A through 15C illustrate the rope grab 100 as it is passing across the bypass bracket 800. The side view of Figure 15B illustrates the rope grab 100 without the fixed side plate 600 for illustration purposes. As illustrated the sleeve 830 that holds the elongated member 920 is received in the cable guide passage 230 of the rope grab 100. The locking cam 300 will allow it to pass unless a fall event occurs. If a fall event occurs when the sleeve 830 is within the cable guide passage 230, the locking cam 300 will lock down on the sleeve 830. Since, the sleeve 830 is locked to the bypass bracket 800 the rope grab 100 will remain stationary to limit the fall. In the top view illustrated in Figure 15C, how the bypass bracket 800 does not interfere with the function of the rope grab 100 is shown. In particular, the second portion 820b of the sleeve clip 820 passes through the opening between the rotating side plate 500 and the cable guide 231 of the housing 200 to position the sleeve 830 and elongated member 920 within the cable guide passage 230 of the rope grab 100. A system may include a plurality of bypass brackets 800 to position a support structure 920 in a desired location.

[0087] Another embodiment of a rope grab 1000 is illustrated in the Figures 16A through 16C. In particular, Figure 16A illustrates a first side perspective view of the rope grab 1000, Figure 16B illustrates a second side perspective view of the rope grab 1000 and Figure 16C illustrates a rear perspective view of the rope grab 1000. Further, an exploded first side view of the rope grab 1000 is illustrated in Figure 17. Similar to the rope grab 100 described above, rope grab 1000 includes a housing 1200, a locking cam 1300, a locking arm 1400, a rotating side plate 1500, and a fixed side plate 1600. The locking cam 1300, the locking arm 1400 and the rotating side plate 1500 are pivotally coupled to the housing 1200.

[0088] The housing 1200 of rope grab 1000 includes rear slot 1207 best shown in Figures 16C and Figure 17. A lever 1700, as discussed below, extends through the rear slot 1207 in this embodiment. Proximate a front first side edge of the housing 1200 is a cable guide 1231 that extends from a first side edge of the housing 1200 in generally a C shape. The cable guide 1231 forms a cable guide passage 1230 (or elongated member passage) that extends from proximate an upper end to a lower end of the housing 1200.

[0089] Proximate the lower end of the housing 1200 and cable guide 1231 is positioned lower roller rivet passages 1240 that pass through the housing 1200. A rivet 1142 passing through the lower roller rivet passages 1240 rotationally couples a lower roller 1134 to the housing 1200. A central post 1204 extends generally perpendicular from the first side of the housing 1200. The central post 1204 is generally located at a mid-portion between an upper end and a lower end of the housing 1200 towards a second side edge of the housing 1200 similar to central post 204 of rope grab 100 discussed above. Also similar to rope grab 100, the cam passage 1340 of the locking cam 1300 as well as passages in the cam spring 1132, the first bearing 1128, washer 1119, second bearing 1117, the spring spacer 1112, the arm spring 1110 are all received around the central post 1204 of the housing 1200. The central post 1204 includes an end portion 1205 that is received in a connection passage 1604 in the fixed side plate 1600 to couple the housing 1200 to the fixed side plate 1600. As with rope grab 100 described above, the housing 1200 includes a cam spring holding channel 1218 that surrounds the central post 1204. The cam holding channel 1218 includes a circular portion and an extending leg portion to hold a first side of the cam spring 1132. A second side of the spring engages the locking cam 1300. This arrangement of the cam spring 1132 provides a relatively light biasing force on the locking cam 1300 to rotate the locking cam 1300 towards an elongated member (cable or rope) in the elongated member passage 1230 of the housing 1200. This relatively light biasing force is countered by gravity in normal climbing operations which

keeps the cam lock 1300 from locking onto the elongated member. Hence during normal operations, the rope grab 1000 moves relatively freely up and down the elongated member. In a free fall (fall event), gravitational forces do not counteract the light biasing force of the cam spring 1132 and the locking cam 1300 will lock onto the elongated member. Inertial loads on the locking cam 1300 during a fall also work in tandem with the light biasing force of the cam spring 1132 to rotate the locking cam 1300 onto the elongated member.

[0090] In rope grab 1000, the locking arm 1400 does not include an energy absorbing portion like locking arm 400 described above. Locking arm 1400, however, does include a locking arm extending portion 1408 and a connecting arm 1404. The locking arm extending portion 1408 is designed to engage a portion of the locking cam 1300 during a fall event to engage a radial edge 1302 into the elongated member as described above regarding locking arm extending portion 408 and the locking cam 300. The connecting arm 1404 includes a connecting aperture 1406 in which a connector 1350 is attached. In particular, a lifeline swivel connector 1122 is coupled to the connecting aperture 1406 of the locking arm 1400 via swivel pivot connector 1118. The swivel lifeline connector 1122 includes a base with a connection passage 1121 and a pair of spaced arms 1122a and 1122b with aligned passages 1123a and 1123b. A pair of spaced arms 1118a and 1118b of a swivel pivot connector 1118 is passed through the connection passage 1121 of the swivel lifeline connector 1122. A head portion 1118c of the swivel pivot connector 1118 has a diameter larger than the diameter of the connection passage 1121 of the swivel lifeline connector 1122. The pair of spaced arms 1118a and 1118b have aligned swivel pivot connection passages 1115a and 1115b. A rivet 1120 passes through the aligned swivel pivot connection passages 1115a and 1115b and the connection passage 1406 of the locking arm 1400 to couple the swivel lifeline connector 1122 to the locking arm 1400. A rivet 1124 passed through the aligned passages 1123a and 1123b of the swivel lifeline connector 1122 is used to couple a lifeline to the rope grab 1000. The carabiner 1350 is selectively coupled to the rivet 1124. The carabiner 1350 would be coupled to a safety harness (not shown) donned by a user.

[0091] The second bearing 1117 is positioned in a main locking arm passage 1412 of the locking arm 1400. The main locking passage 1412 of the locking arm is then positioned around the central post 1204 of the housing 1200 as described above. The spring spacer 1112 is also positioned around another portion of the central post 1204. The coiled portion of the arm spring 1110 is positioned around the spring spacer 1112 while a first end portion 1110a of the arm spring 1110 is received in a spring holding slot 1112b of the spring spacer 1112. The

first end portion 1110a of the arm spring 1110 is further received in a cut out section 1203 of the center post 1204 of the housing 1200. This arrangement holds the first end portion 1110a of the arm spring 1110 in a static position in relation to the housing 1200. A second end portion 1110b of the arm spring 1110 is received in the arm spring groove 1409 of the locking arm 1400 to assert a biasing force on the locking arm 1400 in a locked position.

[0092] The rotating side plate 1500 includes an upper portion with a roller passage 1514 and lower portion with a pivot connection passage 1512. The upper roller 1114 is rotationally coupled to side plate 1500 via pin 1116. The pivot connection passage 1512 receives a second post 1208 of the housing 1200. The rotating side plate 1500 further includes a first edge 1508 and an opposed second edge 1510. The rotating side plate 1500 further includes a first cut out section 1533 that extends in from the second edge 1510 near the lower portion and a centrally located second cut out section 1531 to reduce weight of the rope grab 1000. Also included along the second edge 1510 of the rotating side plate 1500 is a lock surface portion 1511 and an extending tab 1502. The first cut out section 1533 is positioned between the lock surface portion 1511 and the extending tab 1502. A side plate spring 1130 is also received on a second post 1208 of the housing 1200. A biasing force from the side plate spring 1130 engaging the extending tab 1502 biases the rotating side plate 1500 to the retaining configuration. The rotating side plate 1500 must be rotated by hand after lever 1700 (discussed below) is rotated. This is done by pulling back on the rotating side plate 1500 proximate the upper roller 1114. Once in the open position, an elongated member can be slid into or out of the cable passage 1230. Once the elongated member is positioned in or taken out of the cable passage 1230, the rotating side plate 1500 can be released to rotate the rotating side plate 1500 to the retaining position and the lever 1700 can be released to engage the lock member 1106 (discussed below) to the rotating side plate 1500.

[0093] The lever 1700 and an associated lever biasing member 1109 are mounted on a third post 1211 extending from the housing 1200. The lever 1700 is rotationally mounted on the third post 1211. The lever biasing member 1109 biases the lever 1700 into a locked position with one end engaging the lever 1700 and another end engaging the housing 1200. The lock member 1106 and a lock member biasing member 1108 are also mounted on the third post 1211. The lock member biasing member 1108 biases the lock member 1106 in a lock position so that a lock portion 1107 of the lock member engages the lock surface portion 1511 of the rotating side plate 1500. A raised tab 1701 of lever 1700 is received in a slot 1105 of the

lock member 1106 to rotate the lock portion 1107 of the lock member 1106 away from the lock surface portion 1511 of the rotating side plate when the lever 1700 is rotated.

[0094] Referring to the partial views of the rope grab 1000 in Figures 18A and 18B a portion of the operation of the rope grab 1000 is discussed. Figure 18A illustrates the rotating side plate 1500 in a retaining configuration in which a portion of the rotating side plate 1500 proximate the first edge 1508 of the rotating side plate 1500 covers at least a portion of the side opening 1150 to the cable guide passage 1230. In this configuration, an elongated member (not shown in Figure 18A) is retained in the cable guide passage 1230 of the cable guide 1231 of the housing 1200. The retaining configuration is achieved when the extending portion 1107 of the lock member 1106 engages the lock surface portion 1511 of the second edge 1510 of the rotating side plate 1500 which retains the rotating side plate 1500 in a static location in relation to the cable guide 1231. The lock member biasing member 1108 biases the lock member 1106 in this configuration. Figure 18B illustrates the rotating side plate 1500 in an open configuration. In this configuration, a portion of the rotating side plate 1500 proximate the first edge 1508 of the rotating side plate 1500 is moved far enough away from the cable guide 1231 to allow passage of an elongated member into and out of the cable guide passage 1230 through the side opening 1150 to the cable guide passage 1230. To get the rotating side plate 1500 into this configuration in this embodiment, lever 1700 is rotated, which rotates the extending portion 1107 of the lock member 1106 away from the lock surface portion 1511 of the second edge 1510 of the rotating side plate 1500. The biasing force from the side plate spring 1130 engaging the extending tab 1511 biases the rotating side plate 1500 to the retaining configuration. Hence, the rotating side plate 1500 must be rotated by hand after lever 1700 is rotated. This is done by pulling back on the rotating side plate 1500 proximate the upper roller 1114. The rope grab 1000 is designed so that a user can both rotate the lever 1700 and pull back on the rotating side plate 1500 to put the rotating side plate in the open configuration with a single hand. Once in the open position, an elongated member can be slid into or out of the cable passage 1230. Once the elongated member is positioned in or taken out of the cable passage 1230, the rotating side plate 1500 can be released to rotate the rotating side plate 1500 to the retaining position and the lever 1700 can be released to engage the lock member 1106 to the rotating side plate 1500.

[0095] The partial cross-sectional views in Figures 19A and 19B illustrate the rope grab 1000 in use after the elongated member 1702 or 1714 has been positioned within the cable guide passage 1230 of the housing 1200. As illustrated, the elongated members 1702 or 1714

are guided through the cable guide passage 1230 formed by the cable guide 1231 with the upper roller 1114 and the lower roller 1134. During normal use when the user is climbing or descending, the locking cam 1300 rotates to the open position under the influence of gravity, so a minimal (if any) frictional force is applied to the elongated member via the rope grab 1000. Hence, the rope grab 1000, in a normal non-fall event use, is relatively free to move up and down on the elongated member with the movement of the user who would be coupled to the locking arm 1400 via carabiner or other connecting means and safety harness (not shown). Figures 19A and 19B illustrate that the rope grab 1000 can be used on different sized elongated members 1702 and 1714. The portion of the radial engaging edge 1302 of the locking cam 1300 that engages the elongated member depends on the diameter of the elongated member 1702 and 1714.

[0096] As with rope grab 100, during a fall event with rope grab 1000, a user's frontal attachment to the user's harness that is coupled to the locking arm 1400 will pull the locking arm 1400 down, therein rotating locking arm 1400 about the central post 1204. This movement causes the extending portion 1408 of the locking arm 1400 to engage a locking arm engaging surface 1332 of the locking cam 1300 therein pivoting the locking cam 1300 also about the central post 1204 of the housing 1200. This movement of the locking cam 1300 forces the radial engaging edge 1302 of the locking cam 1300 to forcefully pinch a portion of the elongated member 1702 or 1714 between the radial edge 1302 of the locking cam 1300 and the cable guide 1231 of the housing 1200 therein locking movement of the rope grab 1000 in relation to the elongated member 1702 or 1714. The rope grab 1000 will remain locked onto the elongated member 1702 or 1714 until the downward force of the fallen user is removed. As discussed above, also during a fall event, the gravitation forces on the cam lock 1300 are overcome by the light biasing force of the cam spring 1132 as well as by inertial forces, to also cause the cam lock 1300 to lock onto the elongated members 1702 or 1714.

[0097] Another embodiment of a rope grab 2000 is illustrated in the Figures 20A and 20B. In particular, Figure 20A illustrates a first side perspective view of the rope grab 2000, Figure 20B illustrated a second side perspective view of the rope grab 2000. Further, an exploded first side view of the rope grab 2000 is illustrated in Figure 21. Similar to the rope grab 100 described above, rope grab 2000 includes a housing 2200, a locking cam 2300, a locking arm 2400, a rotating side plate 2500, and a fixed side plate 2600. The locking cam 2300, the locking arm 2400 and the rotating side plate 2500 are pivotally coupled to the housing 2200.

[0098] The housing 2200 of rope grab 2000 includes a cable guide 2231 that extends from the first side edge of the housing 2200 in generally a C shape. The cable guide 2231 forms a cable guide passage 2230 (or elongated member passage) that extends from proximate an upper end to a lower end of the housing 2200. Proximate the lower end of the housing 2200 and cable guide 2231 is positioned lower roller rivet passages 2340 that passes through the housing 2200. A rivet 2142 passing through the lower roller rivet passages 2340 rotationally couples a lower roller 2134 to the housing 2200. A central post 2204 extends generally perpendicular from the first side of the housing 2200. The central post 2204 is generally located at a mid-portion between an upper end and a lower end of the housing 2200 towards a second side edge of the housing 2200 similar to central post 204 of cable grab 100 discussed above. Also similar to cable grab 100, the cam passage 2304 of the locking cam 2300 as well as passages in the cam spring 2132, the first bearing 2128, second bearing 2117, the spring spacer 2112, the arm spring 2110 are all received around the central post 2204 of the housing 2200. The central post 2204 includes an end portion 2205 that is received in a connection passage 2604 in the fixed side plate 2600 to couple the housing 2200 to the fixed side plate 2600. As with rope grab 100 described above, the housing 2200 includes a cam spring holding channel 2218 that surrounds the central post 2204. The cam holding channel 2218 includes a circular portion and an extending leg portion to hold a first side of the cam spring 2132. A second side of the spring engages the locking cam 2300. This arrangement of the cam spring 2132 provides a relatively light biasing force on the locking cam 2300 to rotate the locking cam 2300 towards an elongated member (cable) in the elongated member passage 2230 of the housing 2200. This relatively light biasing force is countered by gravity in normal climbing operations which keeps the cam lock 2300 from locking onto the elongated member. Hence, during normal operations, the rope grab 2000 moves relatively freely up and down the elongated member. In a free fall (fall event), gravitational forces do not counteract the light biasing force of the cam spring 2132 and the locking cam 2300 will lock onto the elongated member. Inertial loads on the locking cam 2300 during a fall also work in tandem with the light biasing force of the cam spring 2132 to rotate the locking cam 2300 onto the elongated member.

[0099] In rope grab 2000, the locking arm 2400 does not include an energy absorbing portion like locking arm 400 described above. Locking arm 2400 does include a locking arm extending portion 2408 and a connecting arm 2404. The locking arm extending portion 2408 is designed to engage a portion of the locking cam 2300 during a fall event to engage a radial

edge 2302 into the elongated member as described above regarding the locking arm extending portion 408 and the locking cam 300. The connecting arm 2404 includes a connecting aperture 2406 in which a connector 2350 is attached. In particular, a lifeline swivel connector 2122 is coupled to the connecting aperture 2406 of the locking arm 2400 via swivel pivot connector 2118. The swivel lifeline connector 2122 includes a base with a connection passage 2121 and a pair of spaced arms 2122a and 2122b with aligned passages 2123a and 2123b. A pair of spaced arms 2118a and 2118b of a swivel pivot connection 2118 is passed through the connection passage 2121 of the swivel lifeline connector 2122. A head portion 2118c of the swivel pivot connection 2118 has a diameter larger than the diameter of the connection passage 2121 of the swivel lifeline connector 2122. The pair of spaced arms 2118a and 2118b have aligned swivel pivot connection passages 2115a and 2115b. A rivet 2120 passes through the aligned swivel pivot connection passages 2115a and 2115b and the connection passage 2406 of the locking arm 2400 to couple the swivel lifeline connector 2122 to the locking arm 2400. A rivet 2124 passed through the aligned passages 2123a and 2123b of the swivel lifeline connector 2122 is used to couple a lifeline to the rope grab 2000. The carabiner 2350 is selectively coupled to the rivet 2124. The carabiner 2350 would be coupled to a safety harness (not shown) donned by a user.

[00100] The second bearing 2117 is positioned in a main locking arm passage 2412 of the locking arm 2400. The main locking passage 2412 of the locking arm is then positioned around the central post 2204 of the housing 2200 as described above. The spring spacer 2112 is also positioned around another portion of the central post 2204. The coiled portion of the arm spring 2110 is positioned around the spring spacer 2112 while a first end portion 2110a of the arm spring 2110 is received in a spring holding slot 2112b of the spring spacer 2112. The first end portion 2110a of the arm spring 2110 is further received in a cut out section 2203 of the center post 2204 of the housing 2200. This arrangement holds the first end portion 2110a of the arm spring 2110 in a static position in relation to the housing 2200. A second end portion 2110b of the arm spring 2110 is received in the arm spring groove 2409 of the locking arm 2400 to assert a biasing force on the locking arm 2400 in a locked position.

[00101] The rotating slide plate 2500 includes an upper portion with a roller passage 2514 and lower portion with a pivot connection passage 2512. The upper roller 2114 is rotational coupled to slide plate 2500 via pin 2116. The pivot connection passage 2512 receives at second post 2208 of the housing 2200. The rotating slide plate 2500 further includes a first edge 2508 and an opposed second edge 2510. The rotating side plate 2500 further includes a

first cut out section 2533 that extends in from the second edge 2510 near the lower portion and a centrally located second cut out section 2531 to reduce weight of the rope grab 2000. Also included in along the second edge 2510 of the rotating side plate 2500 is a lock surface portion 2511 and an extending tab 2502. The first cut out section 2533 is positioned between the lock surface portion 2511 and the extending tab 2502. A side plate spring 2108 is also received on a second post 1208 of the housing 2200. A biasing force from the side plate spring 2108 engaging the extending tab 2502 biases the rotating side plate 2500 to the retaining configuration. The rotating side plate 2500 must be rotated by hand after lever 2700 or 2102 (discussed below) is rotated. This is done by pulling back on the rotating side plate 2500 proximate the upper roller 2114. Once in the open position, an elongated member can be slid into or out of the cable passage 2230. Once the elongated member is positioned in or taken out of the cable passage 2230, the rotating side plate 2500 can be released to rotate the rotating side plate 2500 to the retaining position and the lever 2700 or 2102 can be released to engage the lock member 2106 (discussed below) to the rotating side plate 2500.

[00102] In this embodiment, the first lever 2700 includes a lever post 2701 that extends through a first lever passage 2207 in the housing 2200 and a second lever passage 2607 in the fixed side plate 2600. The second lever 2102 and a washer 2104 are mounted to an end of the lever post 2701. Hence, this embodiment has two levers 2700 and 2102 that are connected together that are respectfully positioned on either side of the rope grab 2000. A lock member 2106 is also mounted on the lever post 2701. In particular, a lock tab 2707 extending from the lever post 2701 is received in a lock slot 2109 to lock the rotation of the lock member 2106 with the rotation of the lever post 2701. The lock member 2106 engages the lock surface portion 2511 of the rotating slide plate 2500 to lock the rotating side plate 2500 to cover a side of the cable guide passage 2230 as discussed below. The lock member 2106 includes a cutout section 2107. When the lever post 2701 is rotated by rotating one of the levers 2700 or 2102 and the cutout section 2107 is aligned with the lock surface portion 2511 of the rotating side plate 2500, the rope grab 2000 is in an unlocked configuration and the rotating slide plate 2500 can be moved as discussed below. A lever biasing member 2138 is received around the lever post 2701. The lever biasing member 2138 has one end engaged to the housing 2200 and another end engaged with lever 2700 to bias the lever post 2701 and the connected lock member 2106 in a lock configuration where the cutout section 2107 of the lock member 2106 is not aligned with the lock surface portion 2511 of the rotating side plate.

[00103] Referring to the partial views of the rope grab 2000 in Figures 22A and 22B a portion of the operation of the rope grab 2000 is discussed. Figure 22A illustrates the rotating side plate 2500 in a retaining configuration in which a portion of the rotating side plate 2500 proximate the first edge 2508 of the rotating side plate 2500 covers at least a portion of the side opening 2150 to the cable guide passage 2230. In this configuration, an elongated member (not shown in Figure 22A) is retained in the cable guide passage 2230 of the cable guide 2231 of the housing 2200. The retaining configuration is achieved when the cutout section 2107 of the lock member 2106 is not aligned with the lock surface portion 2511 of the second edge 2510 of the rotating side plate 2500 as illustrated in Figure 22A. As illustrated, the lock member 2106 in this configuration engages the rotating side plate 2500 to maintain the rotating side plate 2500 in a static location in relation to the cable guide 2231. The lever biasing member 2138 biases the lock member 2106 in this configuration as discussed above. Figure 22B illustrates the rotating side plate 2500 in an open configuration. In this configuration, the cutout section 2107 of the lock member 2106 is aligned with the lock surface portion 2511 of the rotating side plate 2500. This allows the rotating side plate 2500 to pivot. When pivoted, a portion of the rotating side plate 2500 proximate the first edge 2508 of the rotating side plate 2500 is moved far enough away from the cable guide 2231 to allow passage of an elongated member into and out of the cable guide passage 2230 through the side opening 2150 to the cable guide passage 2230. To get the rotating side plate 2500 into this configuration in this embodiment, one of the levers 2700 or 2102 are rotated, which rotates the lock member 2106 to align the cutout section 2107 with the lock surface portion. The biasing force from the side plate spring 2108 engaging the extending tab 2502 biases the rotating side plate 2500 to the retaining configuration. Hence, the rotating side plate 2500 must be rotated by hand after the levers 2700 and 2102 are rotated. This is done by pulling back on the rotating side plate 2500 proximate the upper roller 2114. The rope grab 2000 is designed so that a user can both rotate the levers 2700 and 2102 and pull back on the rotating side plate 2500 to put the rotating side plate 2500 in the open configuration with a single hand. Once in the open position, an elongated member can be slid into or out of the cable passage 2230. Once the elongated member is positioned in or taken out of the cable passage 2230, the rotating side plate 2500 can be released to rotate the rotating side plate 2500 to the retaining position and the levers 2700 and 2102 can be released to engage the lock member 2106 to the rotating side plate 2500.

[00104] The partial cross-sectional views in Figures 23A and 23B illustrate the rope grab 2000 in use after the elongated member 2914 or 2920, respectively have been positioned

within the cable guide passage 2230 of the housing 2200. As illustrated, the elongated members 2914 or 2920 are guided through the cable guide passage 2230 formed by the cable guide 2231 with the upper roller 2114 and the lower roller 2134. During normal use when the user is climbing or descending, the locking cam 2300 rotates to the open position under the influence of gravity, so a minimal (if any) frictional force is applied to the elongated member via the rope grab 2000. Hence, the rope grab 2000, in a normal non-fall event use, is relatively free to move up and down on the elongated member with the movement of the user who would be coupled to the locking arm 2400 via carabiner or other connecting means and safety harness (not shown). Figures 23A and 23B illustrate that the rope grab 2000 can be used on different sized elongated members 2914 and 2920. The portion of the radial engaging edge 2302 of the locking cam 2300 that engages the elongated member depends on the diameter of the elongated member 2914 and 2920.

[00105] As with rope grab 100, during a fall event with rope grab 2000, a user's frontal attachment to the user's harness that is coupled to the locking arm 2400 will pull the locking arm 2400 down, therein rotating locking arm 2400 about the central post 2204. This movement causes the extending portion 2408 of the locking arm 2400 to engage a locking arm engaging surface 2332 of the locking cam 2300 therein pivoting the locking cam 2300 also about the central post 2204 of the housing 2200. This movement of the locking cam 2300 forces the radial engaging edge 2302 of the locking cam 2300 to forcefully pinch a portion of the elongated member 2914 or 2920 between the radial edge 2302 of the locking cam 2300 and the cable guide 2231 of the housing 2200 therein locking movement of the rope grab 2000 in relation to the elongated member 2914 or 2920. The rope grab 2000 will remain locked onto the elongated member 2914 or 2920 until the downward force of the fallen user is removed. As with other embodiments, also during a fall event, the gravitation forces on the cam lock 2300 are overcome by the light biasing force of the cam spring 2132 as well as by inertial forces, to also cause the cam lock 2300 to lock onto the elongated members 2914 or 2920.

[00106] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement, which is calculated to achieve the same purpose, may be substituted for the specific embodiment shown. This application is intended to cover any adaptations or variations of the present invention. Therefore, it is manifestly intended that this invention be limited only by the claims and the equivalents thereof.

CLAIMS

1. A rope grab comprising:
 - a housing having an elongated member guide forming an elongated member passage, the elongated member passage configured and arranged to receive an elongated member;
 - a locking cam pivotally coupled to the housing, the locking cam configured and arranged to selectively engage an elongated member received in the elongated member passage;
 - a cam biasing member positioned to provide a relatively slight biasing force on the locking cam towards an elongated member received in the elongated member passage, the relatively slight biasing force being countered by gravity during normal operations of the rope grab; and
 - a locking arm pivotally coupled to the housing, the locking arm having a first end configured and arranged to be coupled to a safety harness of a user and a second end configured and arranged to selectively engage the locking cam to selectively lock the locking cam on an elongated member in the elongated member passage during a fall event.
2. The rope grab of claim 1, further comprising:
 - a rotating side plate pivotally coupled to the housing to selectively block a side opening to the elongated member passage of the housing.
3. The rope grab of claim 2, further comprising:
 - a fixed side plate coupled to the housing, the locking cam, the locking arm and the rotating side plate positioned between the fixed side plate and the housing.
4. The rope grab of claim 1, further comprising:
 - the locking cam having a radial edge that is configured and arranged to engage an elongated member, the radial edge having a curvature that varies in relation to a pivot connection to the housing so that the radial edge engages each elongated member at an contact angle that is the same even when different diameter elongated members are received in the elongated member passage of the housing.

5. The rope grab of claim 1, further comprising:
a fixed side plate coupled to the housing, the locking cam, the locking arm and the rotating side plate positioned between the fixed side plate and the housing;
a spring spacer positioned between the locking arm and the fixed plate, the spacer having a spring holding slot formed in an end of the spacer; and
an arm spring having a first end portion, a second end portion and a coiled portion positioned in between the first end portion and the second end portion, the coiled portion received around the spring spacer, the first end portion of the arm spring received in the spring holding slot of the spring spacer, the first end portion of the arm spring further engaging a portion of the housing, the second end portion of the arm spring engaging the locking arm to provide a biasing force on the locking arm.
6. The rope grab of claim 5, wherein the housing includes a post with a cut out section, the spring spacer having a central passage, the post of the housing received in the central passage and the first end portion of the arm spring received in the cut out section of the post to engage the first end portion of the arm spring to the housing.
7. The rope grab of claim 2, further comprising:
at least one roller coupled proximate an end of the rotating side plate, the at least one roller configured to guide an elongated member through the elongated member passage.
8. The rope grab of claim 2, further comprising:
a side plate spring coupled between the housing and the rotating side plate to provide a biasing force on the rotating side plate.
9. The rope grab of claim 2, further comprising:
at least one lever;
a lever spring coupled between the housing and the at least one lever to provide a biasing force on the at least one lever;
a lock member coupled to rotate in response to the rotation of the at least one lever, the lock member configured and arranged to selectively engage the rotating side plate to lock the rotating side plate in a static position in relation to the housing to selectively block at least a portion of the side opening to the elongated passage; and

a lock spring coupled between the housing and the rotating side plate to provide a biasing force on the rotating side plate.

10. The rope grab of claim 9, further comprising:

the lever extending through a slot in the housing.

11. The rope grab of claim 1, wherein the locking arm includes an energy absorbing portion configured and arranged to absorb energy during a fall event.

12. A rope grab comprising:

a housing having an elongated member guide forming an elongated member passage, the elongated member passage configured and arranged to receive an elongated member;

a locking cam pivotally coupled to the housing, the locking cam configured and arranged to selectively engage an elongated member received in the elongated member passage, the locking cam having a radial edge that is configured and arranged to engage the elongated member, the radial edge having a curvature that varies in relation to a pivot connection to the housing so that the radial edge engages each elongated member at a contact angle that is the same even when different diameter elongated members are received in the elongated member passage of the housing; and

a locking arm pivotally coupled to the housing, the locking arm having a first end configured and arranged to be coupled to a safety harness of a user and a second end configured and arranged to selectively engage the locking cam to lock the locking cam on an elongated member during a fall event.

13. The rope grab of claim 12, further comprising:

a rotating side plate pivotally coupled to the housing to selectively block at least a portion of a side opening to the elongated member passage of the housing to selectively retain an elongated member within the elongated member passage.

14. The rope grab of claim 12, further comprising:

a cam spring coupled between the housing and the locking cam to provide a relatively slight biasing force on the locking cam in a direction towards an elongated member received in the elongated member passage.

15. The rope grab of claim 12, further comprising:
a fixed side plate coupled to the housing, the locking cam, the locking arm and the rotating side plate positioned between the fixed side plate and the housing;
a spring spacer positioned between the locking arm and the fixed plate, the spacer having a spring holding slot formed in an end of the spacer; and
an arm spring having a first end portion, a second end portion and a coiled portion positioned in between the first end portion and the second end portion, the coiled portion received around the spring spacer, the first end portion of the arm spring received in the spring holding slot of the spring spacer, the first end portion of the arm spring further engaging a portion of the housing, the second end portion of the arm spring engaging the locking arm to provide a biasing force on the locking arm.
16. The rope grab of claim 13, further comprising:
at least one roller coupled proximate an end of the rotating side plate, the roller configured to guide an elongated member through the elongated member passage.
17. The rope grab of claim 13, further comprising:
at least one lever;
a lock member coupled to rotate in response to the rotation of the at least one lever, the lock member configured and arranged to selectively engage the rotating side plate to lock the rotating side plate in a static position in relation to the housing to selectively block at least a portion of the side opening to the elongated passage;
a lock spring coupled between the housing and the rotating side plate to provide a biasing force on the rotating side plate; and
a lever spring coupled between the housing and the at least one lever to provide a biasing force on the at least one lever.
18. The rope grab of claim 12, wherein the locking arm includes an energy absorbing portion configured and arranged to absorb energy during a fall event.
19. A rope grab system comprising:
at least one bypass bracket configured and arranged to couple an elongated member to a support structure; and
a rope grab including,

a housing having an elongated member guide forming an elongated member passage, the elongated member passage configured and arranged to pass an elongated member and a portion of the at least one bypass bracket there through,

a locking cam pivotally coupled to the housing, the locking cam configured and arranged to selectively engage one of the elongated member and the portion of the at least one bypass bracket, and

a cam spring coupled between the housing and the locking cam to provide a relatively slight biasing force on the locking cam towards the elongated member and the portion of the at least one bracket received in the elongated member passage, the relatively slight biasing force being countered by gravity during normal operations of the rope grab.

20. The rope grab system of claim 19, wherein the rope grab further comprises:

a locking arm pivotally coupled to the housing, the locking arm having a first end configured and arranged to be coupled to a safety harness of a user and a second end configured and arranged to selectively engage the locking cam to selectively lock the locking cam on one of the elongated member and the portion of the at least one bypass bracket during a fall event.

21. The rope grab system of claim 19, wherein the bypass bracket further comprises:

a base bracket configured and arranged to be coupled to the support structure;
a sleeve clip coupled to the base bracket, the sleeve clip including spaced opposably faced first and second holding ears; and

a tubular sleeve having a central passage and spaced first and second opposably positioned recesses formed in an outer surface of the sleeve, the first and second holding ears of the sleeve clip configured and arranged to selectively receive the respective first and second opposably positioned recess of the tubular sleeve.

22. A method of manipulating a rope grab, the method comprising:

rotating a lever rotationally coupled to a housing to release a rotating side plate with a hand of a user;

pulling back on an end of the rotating side plate to pivot a portion of the rotating side plate away from a side opening to an elongated member passage formed in the housing with the hand of the user;

positioning the rope grab to receive an elongated member within the elongated member passage of the housing with the hand of the user; and

releasing the rotating side plate to allow the rotating side plate to at least partially cover the side opening to the elongated member passage of the housing to retain the elongated member with the elongated member passage.

23. The method of claim 22, further comprising:

rotating a lever rotationally coupled to a housing to release a rotating side plate with a hand of the user;

pulling back on an end of the rotating side plate to pivot a portion of the rotating side plate away from a side opening to an elongated member passage formed in the housing with the hand of the user;

removing the elongated member from the elongated member passage of the housing with the hand of the user; and

releasing the rotating side plate to allow the rotating side plate to at least partially cover the side opening to the elongated member passage of the housing.