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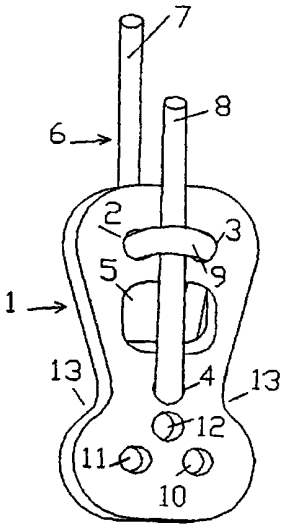

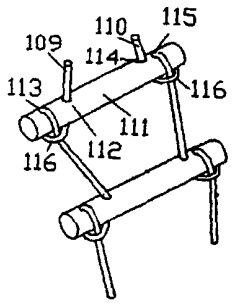

(57) **Abstract:** This invention relates for creating a one-way clutching action between a frame body member (1) and a ligature (6). Three methods defined by two (2) and three (3) hole arrangements and loop (9) turning method. In either of the methods, properly spaced, strategically located holes (2 and 4) of proper size are provided within the body of the frame (1). These methods have variety of usage and can be applied to many different applications. Examples by a single body knot (17) for positive locking, and infinite adjustment, and comes apart with ease. Or by other products where a one-way clutching provides definite advantages. The invention extends the methods to the ligature ladders and other ligature ascending devices also. The structure in either case comprises of parallel ligatures (109, 110) and stepping element (111) the steps (111) connected to the ligatures (109, 110) by one-way clutching. The steps (111) connected to the ligatures (109, 110) by a loop (116) turning method.

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ONE-WAY CLUTCHING METHODS BETWEEN A LIGATURE AND A FRAME AND THEIR APPLICATIONS

BACKGROUND OF THE INVENTION

This invention centers around discovered methods of providing a one-way clutching action between a ligature and a frame and applications of the methods to specific products. The discovered methods provide a positive locking (i.e. no possible relative motion) between a ligature and a frame in one direction. However, a relative motion between the ligature and the frame in the opposite direction is possible. One objective of this invention is then to discuss the discovered method of providing a one-way clutching action between a ligature (i.e. rope, etc.) and a frame. Another objective of this invention is to explore the adaptation of the methods of one-way clutching by other products. Three methods for creating one-way clutching are discussed. The methods are "3-hole method", "2-hole method" and, "loop-turning method". The methods have diverse applications. They can be incorporated into existing products or be used in creating new products. The products discussed in this document include wearables (i.e. shoes, boots, clothing items, hats, helmets, hair bows, etc.), tents, cargo covers, luggage carriers, convertible tops; ligature ladders, ascending/descending devices, packaging items, seat belts, exercise devices, power transmissions, etc. Further, the invention allows quick release or adjustments of the ligature with respect to the frame without the use of any tools. The frame, depending on the application, may be made from any rigid, elastic (or in between) material. Ligature includes ropes, straps and metal, plastic or composite wires, etc.

SUMMARY OF THE INVENTION

The invention is based on the inventor's discovered methods of creating a one-way clutching action between one body (a frame) and a flexible body (i.e. a ligature). The term frame is to be interpreted in a broad sense. The frame can be a new product or an

existing product. In general, wherever a ligature has to interact with another object this invention offers practical advantage.

The invention is based on a ligature forming a specific size loop within the body of a frame. The ligature after following a path ends up passing underneath the loop. As a result, relative motion between the ligature and the frame is possible only in one direction. This principle is extended into many variations and numerous applications.

There are three ways for creating a one-way clutching between a frame and a ligature. The methods are: "3-hole method", "2-hole method" and, "loop-turning method". The methods are based on creating a dynamic frictional lock between two overlapping segments of the ligature. The dynamic characteristics of the system are due to the proportional increase in the frictional force, within the overlapping segments of the ligature, as a function of the applied force.

The frame in the 2-hole method and in the loop-turning method is comprised of sets of paired holes. In the 3-hole method, the frame is comprised of sets of 3 holes; two of the 3 holes in each set will be paired and closely spaced. In either the 2-hole method or the 3-hole method, the holes that are paired should be spaced apart by a specific distance. If the ligature has a round cross section, the inner edge to inner edge distance between the paired holes should approximately be equal to the diameter of the ligature. If the ligature has a flat cross section, the inner edge to inner edge distance between the paired holes should not be longer than the width of the ligature. From the mechanical view point the distance between the paired holes is critical because the space allows the necessary positive locking when an overlap between two segments of the ligature is established. In the case of a 3-hole method, the third hole normally is located in such a manner that the three holes form a triangle.

In either 2-hole or 3-hole methods, the ligature enters and exits the two closely spaced holes sequentially forming a loop called loop1 between the two closely spaced holes. The ligature, in the case of a 2-hole method, loops around the edge of the frame and

passes underneath loop1. In the case of the 3-hole method, the ligature after forming loop1 between the pairs of closely spaced holes 1 and 2 enters and exits from the third hole before passing underneath loop1. The end of the ligature out from underneath loop1 is being named "free end" in all future references. The free end can be pulled freely with respect to the frame. However, exertion of any tensile force on the other end of the ligature increases the friction force between the two overlapping layers of the ligature causing the ligature and the frame to interlock.

The invention provides two different methods for facilitating the unlocking of the system or establishing means for quick adjustment. One method is to introduce a gap between the frame and the ligature. The gap allows the user to hold the ligature and pull it from underneath loop1. To provide the gap, in the 3-hole method, either openings separate the two paired holes 1 and 2 from the third hole or the third hole will be set at a different elevation. In the case of a 2-hole method, the grooved or stepped edge of the frame provides the necessary gap between the ligature and the frame. The second method employs a body to form a complete loop around loop1. In a preferred practice, the same ligature that interacts with the frame is used to form the complete loop. Such complete loop is formed when the free end of the ligature is passed underneath loop1 again. Securing means (such as cable or wire tie) can be used to secure the complete loop around loop1. Pulling the complete loop upward unlocks the system. Pulling the end of the ligature, which is in the immediate vicinity and underneath loop1, tightens (locks) the system.

The frame in the loop-turning method is comprised of sets of paired holes. The two holes that form the paired holes in each set should be spaced close to each other. A ligature enters and exits one of the paired holes. The ligature then forms a 1/2 turn loop around the body of the frame before entering and exiting the other hole of the set. A force applied to the frame causes the frame to move freely along the ligature. However, a simple turning of the mentioned 1/2 turn loop over the edge of the frame from one side to the other establishes an overlap between two segments of the ligature. This overlap prevents any relative motion between the frame and the ligature in one

direction. Relative motion between the ligature and the frame is possible in the opposite direction. In other words, the simple loop turning makes the assembly a one-way clutch!

The mentioned methods of forming a one-way clutching action have many diverse applications. Citing every single use is totally beyond the scope here. In general, wherever a ligature has to interact with another object the methods of one-way clutching offer themselves useful. Essentially, either an object (that requires interaction with a ligature) adopts the methods of one-way clutching within its body, or a separate frame interfaces the object and its ligature. A few examples are cited here and are detailed in the following sections.

The methods of one-way clutching have applications in wearables (i.e. clothing items, gloves, shoes, helmets, boots, hair bows, etc.). Here, either the wearable itself plays the role of the frame or a separate frame acts as an interface between the wearable and its ligature. In either case a permanent yet adjustable knot will replace traditional methods of fastening. In addition, methods are invented that need only one hand to tighten or loosen a ligature. This makes the methods appealing for people who have only one hand. Another advantage being that the permanent knot that is formed by the one-way clutching methods will never come loose on its own relieving the user from worrying about his/her wearable getting untied. Different designs for adopting the methods to wearables are discussed.

In packaging, the one-way clutching methods can be an integrated part of the body of the package. This discussion extends itself to luggage carriers such as car top luggage carriers as well. Similarly, the methods extend to fixtures for securing several wires together.

In tents the one-way clutching methods can be an integrated part of the structure of the tent or its peg. This discussion extends itself to similar structures such as parachutes, convertible tops, and cargo covers. The same extends to ligatures used for securing a pole or a tree to a fixed object such as the ground.

In belts, including seat belts, the one-way clutching methods can be an integrated part of the belt or its buckle. The body of the belt is totally or partially comprised of a ligature.

In ligature ladders, the one-way clutching methods offer a simple structure for a totally adjustable ligature ladder where ladder steps lock to the support ligatures in one direction and are free to move in the opposite direction.

The methods have application in ascending/descending devices as well. Such device is composed of two pairs of parallel ligatures. Two step-elements, each having adopted a method of one-way clutching, intermediate each pair of parallel ligature. The ascender pushes and pulls the step elements up the parallel ligatures as he/she climbs. A variation of the mentioned structure has application as a muscle exerciser.

In surgery the methods have potential application. Here, segments of the body to be stitched play the role of a frame.

In pulling or lifting devices, the methods have proven applications as well. Here the frame is held fixed, one end of the ligature is connected to the object being pulled or lifted. Pulling the other end of the ligature moves the object toward the frame.

In power transmission, a fixed frame intermediates the driver and the driven elements via a power transmission ligature. This arrangement allows power transmission only in one direction and prevents transfer of power in the opposite direction. Conventional one-way clutches interact directly with the driver or the driven elements. However, in this invention the frame interacts directly with the ligature that connects the driver and the driven elements.

BRIEF EXPLANATION OF THE DRAWINGS

Figure 1 shows a frame - ligature assembly using the 3-hole method. Here an opening

within the frame provides the gap between the frame and the ligature.

Figure 2 shows a frame using the 3-hole method. Here the central hole is set at a higher

elevation in order to create a gap between the frame and the ligature.

Figure 3 shows a frame - ligature assembly using the 2-hole method. Here the edge of the frame provides the necessary gap between the frame and the ligature.

Figure 4 shows a frame - ligature assembly using the 3-hole method. Shown here is how the ligature forms loops used in unlocking the system.

Figures 5 show the force analysis; stressing the importance of keeping paired holes separated from each other by a specific distance.

Figures 6 show methods for reducing the friction between the frame and the ligature.

Figures 7 show the loop-turning method applied to a round frame.

Figures 8 show how the direct application of the2-hole method to wearables (the shoe shown represents a wearable).

Figures 9 show how the direct application of the 3-hole method to wearables (the shoe shown represents a wearable).

Figure 10 shows an alternative way of applying the 2-hole method directly to wearables (the shoe shown represents a wearable).

Figures 11 show how a separate frame with integrated 3-hole method interfaces a wearable and its ligature (the shoe shown represents a wearable).

Figures 12 show another possible way that a separate frame with integrated 3-hole method interfaces a wearable and its ligature (the shoe shown represents a wearable).

Figures 13 show yet another possible way that a separate frame with integrated 3-hole method interfaces a wearable and its ligature (the shoe shown represents a wearable).

Figures 14 show variation in the design of a frame which interfaces a wearable and its ligature.

Figure 15 shows adaptation of the 2-hole method to a ligature ladder.

Figures 16 show adaptation of the loop turning method to ligature ladder

Figure 17 show an ascending/descending composed of parallel ligatures and only 4

steps

Figure 18 shows a power transmission assembly. Here a fixed frame using the 3-hole method intermediates the power transmitting ligature.

DESCRIPTION OF THE INVENTION

This invention centers around inventor's discovered methods of creating a one-way clutching action between a ligature and a frame. Three methods, 2-hole method, 3-hole method and loop-turning method, and their applications are discussed. The first part of this document explains the cited methods followed by examples of the adaptation of the methods by other products.

In accordance with this invention, a frame is provided. The frame depending on where and why the one-way clutching is needed, can be made from wood, plastic, leather, fabric, cardboard, metals, composites, etc. The frame provides strategically located openings or holes. Cross section of holes should be similar to and a bit larger than the cross section of the ligature. The strategically located openings allow relative motion between the ligature and the frame only in one direction. Further, the strategically located openings also provide for easy releasing or adjusting of the lock formed between the ligature and the frame. Since the frame is needed only to carry the openings, the frame itself can assume many different shapes depending on the particular usage or cosmetic requirement. The frame can be a simple flat body, a spherical body, cylindrical body, elliptical body or any combination thereof. Further, the frame can be another product altogether. Any product where an interaction with a ligature is normally needed can potentially serve as a frame and adopt the cited methods within its body.

The frame plays the central role in this invention. To conform to the one-way clutching method, the frame will have sets of 2 holes in the 2-hole method, or sets of 3 holes in the 3-hole method. In a preferred practice, the three mentioned holes of the 3-hole

method should form an isosceles triangle. In either case of the 2-hole method or the 3-hole method, two of the holes in each set should be spaced apart by a specific distance. For ligatures with a round cross section, the specific distance, measured from the inner edge of one hole to the inner edge of the other hole, should approximately be equal to the diameter of the ligature. Otherwise for ligatures with a flat cross section, the specific distance, measured from the inner edge of one hole to the inner edge of the other hole, should not be more than the width of the ligature. From the mechanical viewpoint, this is an important aspect of this invention because maintaining the mentioned specific distance between at least two of the holes assures a positive locking between the ligature and the frame in one direction regardless of the magnitude of the applied load. With this arrangement, as the load increases, the friction force increases as well assuring the formation of a positive lock between the frame and the ligature.

The methods of one-way clutching will be fully understood from the accompanying drawings. Referring to figure 1 that shows the 3-hole method, the frame is identified as 1, the three holes are identified as 2, 3 and 4, and the opening separating the two closely spaced holes 2 and 3 from the third hole 4 is marked as 5. The ligature is marked as 6. The normally loaded (i.e. active or under tension) side of the ligature is marked as 7 and the normally loose end (or free end) of the ligature is marked as 8. Holes 2 and 3 should be spaced apart by the mentioned specific distance. As shown in figure 1, ligature 6 enters and exits from holes 2 and 3 sequentially. In this manner loop 9 is formed by ligature 6 between holes 2 and 3. Loops such as loop 9, formed by the ligature within the body of the frame is referred to as loop1 in claims and in other references throughout this document. Ligature 6 after forming loop 9 enters and exits hole 4 before passing underneath loop 9. When a tensile force is applied to the end 8 of ligature 6, a relative motion between ligature 6 and frame 1 is possible. However, when a tensile force is applied to end 7 of ligature 6, the segment of ligature 6 that forms loop 9 push on the segment underneath and an interlock between frame 1 and ligature 6 will be established. The larger the tensile force applied to end 7 of ligature 6, the larger the friction force between loop 9 and the segment underneath loop 9 and the stronger is the lock between ligature 6 and frame 1. To release (untie) the lock between ligature 6 and

frame 1 with ease an opening 5, as shown in figure 1, is introduced separating holes 2 and 3 from hole 4. Opening 5 allows the user to slip his/her fingers around the portion of ligature 6 that passes over opening 5 and to pull it from underneath loop 9. This pulling from underneath loop 9 creates a relaxation in end 7. This relaxation reduces the friction force between the overlapping segments of ligature 6 and releasing is imminent. Alternative way for creating a gap between ligature 6 and frame 1 is to set hole 4 at a different elevation than holes 2 and 3 as shown in figure 2. Here ligature 6 follows the same path as shown in figure 1. The gap between ligature 6 and frame 1 is formed close to the edge of hole 4. There may be multiple sets of holes 2, 3, 4, and 5 enabling multiple ligature ends to be tied down to the same frame. Figure 1 shows holes marked as 10, 11 and 12. The functions of these holes are the same as holes 2, 3 and 4. Holes 10, 11 and 12 are used to connect the other end of ligature 6 or an end of another ligature to the frame. In some applications curvatures 13 are provided along the boundary of frame 1, as shown in figure 1. Curvatures 13 allow holding frame 1 between thumb and index fingers of one hand while the other hand pulls end 8 of ligature 6 in order to tighten the system.

The 2-hole method is shown in figure 3. Frame is marked as 1 and ligature as 6. Holes 14 and 15 should be spaced apart by the mentioned specific distance. Ligature 6 enters and exits hole 14 and hole 15 in sequence forming loop 9 between holes 14 and 15. Ligature 6 then forms a loop around the edge of frame 1 before passing underneath loop 9. The 2-hole method functions the same as the 3-hole method except that the gap between ligature 6 and frame 1 is provided through a stepped structure 16 at the edge of frame 1. It is understood that a groove within the edge of frame 1 can be used instead of the stepped structure.

A different method for quick unlocking of the system is through formation of a complete loop by ligature 6 around loop 9. Figure 4 shows that end 8 of ligature 6 forms complete loop 17 around loop 9. Complete loop 17 is secured by element 18. Pulling segments of ligature 6 that are secured by element 18 upward loosens the system. This upward motion pulls loop 9 upward and enables loosening of the lock. To

tighten (lock) the system segment 19 of ligature 6 must be pulled. Obviously, instead of using ligature 6 to form a complete loop around loop 9, one may employ a separate body for the same function.

Figures 5A and 5B show force analysis for a ligature that has a round cross section. The analysis stresses the importance of maintaining the mentioned specific distance between two paired holes. In figure 5A, the segment of the ligature under loop1 is marked as 20, the two paired holes are marked as 2 and 3. The vertical force on section 20 is equal to twice of the tensile force F within the body of the ligature multiplied by cosine of the angle shown by numeral 21 (i.e. 2*F*COS(21)). The maximum force on section 20 occurs when angle 21 is equal to zero. Angle 21 is equal to zero when the inner edge to inner edge distance between holes 2 and 3 is equal to the diameter of the ligature (figure 5B). Conclusion is drawn here that in order to establish an optimum performance, the distance between two paired holes should be equal to the diameter of the ligature. For a ligature with a flat cross section, following the same analysis, establishes that the inner edges of holes 2 and 3 should not be spaced apart more than the width of the ligature. It is understood that in practice this distance can be set a little longer or little shorter than the recommended distance.

Obviously all edges are smooth and all holes have smooth boundaries. Bushings or eyelets may be employed to facilitate relative motion between ligature 6 and frame 1. In some applications it may be necessary to reduce the friction between the ligature and the frame. One may employ pulleys and/or rollers or use a protective layer made from low friction materials to reach this objective. Figure 6A shows a typical situation where roller 22 is used. Figure 6B show a typical situation where pulleys 23 and 24 are used. Figure 6C shows one possible way for using a protective shell 25 to reduce friction between the frame and the ligature.

Other variations for the design include making the gap between the frame and the ligature adjustable. One can simply achieve this by making hole 4 of figure 2 as a separate body which threads into frame 1.

Figures 7A and 7B shows the principle behind the loop turning method. Frame 26, as shown in figures 7A and 7B, comprised of a pair of closely spaced holes 27 and 28. Ligature 29 enters and exits hole 27. Ligature 29, in a preferred practice, makes a 1/2 turn loop around the body of frame 26 before entering and exiting hole 28. It is understood that ligature 29 can make one or more complete loops around frame 26 before entering and exiting hole 28. Any force applied to frame 26 causes frame 26 to move along ligature 29. However, as shown in figure 7B, when the 1/2 turn loop is turned from one side to the other side, over an edge of frame 26, two segments of ligature 29 overlap. The overlap prevents any relative motion between frame 26 and ligature 29 in one direction. However relative motion is possible in the opposite direction. The loop turning then creates a one-way clutching action between frame 26 and ligature 29. To reverse the direction of the possible relative motion, one can turn the 1/2 turn loop over the opposite edge of frame 26. Alternatively, reversing the order in which ligature 29 enters holes 27 and 28 reverses the direction of possible relative motion between ligature 29 and element 26. In figures 7A and 7B one end of the ligature points upward and the other end points downward. Figure 7C shows a variation where both ends point in the same direction. Here, ligature 29 enters hole 27 then forms a complete loop around the body of frame 26 before entering hole 28. The system works the same as the systems in figure 7A and 7B.

Examples of the applications of the methods to specific products

This invention has numerous applications. Anywhere that a ligature and a body have to interact this invention offers a functional use. Advantages over conventional methods of forming a knot are the possibility for infinite adjustment and the ease of unlocking. The examples that are mentioned in the following by no means constitute a complete list.

Throughout this document the term frame is being defined as any structure with at least

one of the methods of one-way clutching integrated within its body.

In wrapping and packaging, one can use ligatures to form loops around the package. Ends of the ligatures then will be locked into a frame. Alternatively, the package itself can have as part of its structure an integrated frame. Knot zappy is the name given to a frame used in general packaging. Knot zappy may have a structure similar to the one shown in figure 1. Several Knot Zappys may share a common axis (i.e. be connected to a bar). Knot Zappys should be able to freely turn around such axis. This allows connecting to ligatures in different directions.

The frame as defined in this invention can replace a belt buckle. Thus providing an endless and easy adjustment for the belt. Alternatively, the body of the belt itself can function as a frame. This eliminates the need for a separate buckle. The term belt and buckle includes seat belts and other similar structures.

Another use for the methods of one-way clutching is in tents and similar structures. Segments of the tent that connects, by a ligature, to a tent peg, can adopt the methods of one-way clutching and function as a frame. Similarly, the tent peg can adopt the methods of one-way clutching and function as a frame as well. The user then can simply lock one end of the ligature to the tent and the other end to the peg. With this arrangement infinite adjustments and easy release is at hand. Similarly, structures such as parachutes, convertible tops and cargo covers can take advantage of the mentioned methods.

Since hammocks are usually made from an array of ropes connected to a rigid body, the methods of one-way clutching can be used at the junction of the ropes and the rigid body.

The methods of one-way clutching have applications in the design of auto top luggage racks as well. Here the rack itself serves as the frame with an integrated method of one-way clutching within its body.

Another use for this invention is in the design of backyard swings. Here the body of the swing itself functions as a frame that connects via a ligature to a support structure (i.e. a tree). Alternatively, a separate frame can be employed to function as an interface between the swing body, its ligature and the support ligature.

The methods have application in pulling and lifting devices as well. In this application the frame will be set fixed at a desired location. The object to be pulled or lifted will be connected to end 7 of ligature 6 (figure 1). Pulling end 8 of ligature 6 pulls or lifts the object toward the frame. The advantage is that one does not have to continuously exert a tension on end 8. If the tension on end 8 is released, the system locks itself and the object remains locked in its position. This discussion extends itself to towing devices as well.

Another application for the methods of one-way clutching is in surgery. In some surgeries the surgeon uses a ligature to close the cuts and then forms a knot between the two ends of the ligature. When the methods of one-way clutching are applied, the part of the body to be stitched functions as a frame thus, providing an easy and adjustable method for closure of the cut. Alternatively, a separate frame can be used to lock the ends of the ligature.

Other applications include a potential use in hair bows. Similarly the methods provide an adjustable and releasable means when securing several wires together.

Applying the methods of one-way clutching to wearables creates a permanent knot that the user can simply tighten or loosen as needed. There are several methods for adopting the one-way clutching methods to wearables. The wearables include clothing items, shoes, gloves, boots, helmets, etc. Figures 8A and 8B show the 2-hole method adapted to a shoe. Other wearables follow suit. Here, shoe 30 comprised of at least one set of holes 31 and 32 on either side of its longitudinal opening 33. Holes 31 and 32 should be spaced apart by the mentioned specific distance. Shoelace 34 forms loop 35 between

holes 31 and 32. Ligature 34 then loops around the edge of longitudinal opening 33 before passing underneath loop 35. The other end of shoelace 34 interacts the same way with pairs of holes on the opposite side of longitudinal opening 33. Simply pulling end 36 of shoelace 34 tightens shoe 30. Untying is done by pulling end 36 out from underneath loop 35. There are several ways that one can facilitate untying of shoelace 34. These approaches follow previous discussions of forming a gap between the ligature and the frame. Specifically, one approach (not shown) is to set the edge of longitudinal opening 33 at a different elevation than the elevation of holes 31 and 32. Another approach is to introduce an opening between loop 35 and the edge of longitudinal opening 33. The purpose is to create a gap between shoelace 34 and shoe 30. The gap provides space where the user can hold and pull shoelace 34 out from underneath loop 35. Alternatively, in a preferred practice, a complete loop 37 is formed by shoelace 34 around loop 35 and is secured by element 38 as shown in figure 8B. Pulling the segments secured by element 38 loosens the lock between shoelace 34 and shoe 30. Tightening is done by pulling the segment of the shoelace immediately out from underneath loop 35 (i.e. segment 36, figure 8B).

Figures 9A and 9B show the integration of the 3-hole method in shoes. The numerals marking figures 9A and 9B are the same as numerals in figures 8A and 8B except for additional hole 39. Shoe 30 is comprised of at least one set of 3 holes 31, 32 and 39 on either side of its longitudinal opening 33. Holes 31 and 32 should be spaced apart by the mentioned specific distance. In a preferred practice, the 3 holes 31, 32 and 39 form a triangle. Shoelace 34 enters and exits holes 31 and 32 in sequence forming loop 35 between holes 31 and 32, as shown in figure 9B. Shoelace 34 then enters hole 39 before passing underneath loop 35. To facilitate the tightening and loosening of shoelace 34, methods of providing a gap between the ligature and the frame is applicable here. These methods are the same as was discussed above in relation to the 2-hole method. Figure 9B shows a preferred practice of forming a complete loop 37 by shoelace 34 around loop 35. Element 38 secures complete loop 37. Again, pulling complete loop 37 loosens the system. Tightening is done by pulling end 36 of shoelace 34.

Figure 10 shows yet another method of adopting the 2-hole method to shoes or other wearables. Here longitudinal opening 33 comprises of sets of paired holes. Holes 31 and 32 form one such pair. Holes 40 and 41 are the corresponding pair of holes alongside the opposite side of longitudinal opening 33. Holes 31 and 32 should be spaced apart by the mentioned specific distance. The same applies to holes 40 and 41. Ligature 34 forms loop 35 between holes 31 and 32. Both ends of ligature 34 after passing through holes 40 and 41 pass underneath loop 35. Pulling both ends of ligature 34 outward tightens the assembly. Pulling ligature 34 out from underneath loop 35 loosens the assembly. In a preferred practice, one forms a complete loop around loop 35. The function of the complete loop is the same as was discussed before.

In some applications the longitudinal opening may require a rigid or semi rigid edge. To give the edge some degree of rigidity metals, plastics, leather or similar material may be introduced as part of the structure of the edge of the longitudinal opening.

In the previous sections methods where a wearable itself functioned as a frame were discussed. There are several methods where a separate frame functions as an interface between a wearable and its ligature. Figures 11, 12, 13 and 14 show these methods applied to shoes. Other wearables follow suit. In the case of a shoe the separate frame that interfaces the shoe and its shoelace is called a shoe zappy. In figure 11A, 42 is a shoe having a series of holes alongside its longitudinal opening 43. Two such side by side holes are marked as 44 and 45. Shoelace is 46, frame or shoe zappy is 47. Shoe zappy 47 comprises of 5 holes 48, 49, 50, 51 and 52. Hole 50 is centrally located. Holes 48 and 49 should be spaced apart by the mentioned specific distance. This applies to holes 51 and 52 as well. Shoelace 46 after criss-crossing through all but hole 45, enters and exits hole 48 and 49 of shoe zappy 47 in sequence forming loop 53 between holes 48 and 49. Shoelace 46, then, first enters hole 45 of shoe 42 (figure 11A), and next, enters hole 50 of shoe zappy 47 before passing underneath loop 53 as shown in figure 11B. The other end of shoelace 46 interacts with the holes on the opposite side of longitudinal opening 43 and holes 50, 51 and 52 of shoe zappy 47 in a similar fashion. In order to facilitate untying, in a preferred practice, shoelace 46 forms a complete loop

around loop 53. Figure 11C shows the top view of shoe zappy 47 after both ends of the shoelace 46 have formed complete loop 54 around loop 53 on their respective side. Element 55 secures complete loop 54 around loop 53. Loosening of shoelace 34 is done by pulling segments under element 55. Tightening is done by pulling segments 56 and 57 of shoelace 46 simultaneously. Obviously shoelace 46 can criss-cross through all holes including hole 45 before forming loop 53 in shoe zappy 47. In this case, after formation of loop 53, shoelace 46 passes through hole 50 of shoe zappy 47 before passing underneath loop 53.

Figures 12A and 12B show another method of using a frame to interface a wearable and a ligature. In this method one end of the frame, in a preferred practice, is secured to or is an integrated part of the wearable. Otherwise, two independent ligatures are used; each ligature interacting with one side of the frame. In figures 12A and 12B application of the method to shoes are shown. Other wearables follow suit. In figure 12A and 12B only one shoelace is shown. If used, the other shoelace interacts with shoe zappy and the shoe in exactly the same way as the shoelace shown in figures 12A and 12 B. In figure 12A, 58 is a shoe having longitudinal opening 59. Longitudinal opening 59 has alongside its edge a series of holes. 60 and 61 are two side by side hole of longitudinal opening 59. Shoelace is marked as 62 and frame or shoe zappy is marked as 63. Shoe zappy 63 has five holes 64, 65, 66, 67 and 68. Holes 64 and 65 should be spaced apart by the mentioned specific distance. The same applies to the paired holes 67 and 68. Shoelace 62 forms loop 69 between holes 64 and 65. Shoelace 62 after passing through holes 60 and 61, passes through central hole 66 of shoe zappy 63. Both ends of shoelace 62 then pass underneath loop 69. Pulling ends 70 and 71 of shoelace 62 outward tightens the assembly. Pulling shoelace 62 out from underneath loop 69 loosens the assembly. In a preferred practice, to facilitate untying, both ends 70 and 71 of shoelace 62 form a complete loop around loop 69. Figure 12B shows complete loop 72 formed by shoelace 62 around loop 69. Element 73 secures complete loop 72 around loop 69. Pulling segments secured by element 73 loosens the system.

Figures 13A and 13B show yet another method for using a separate frame to interface a

wearable and a ligature. Figures 13A and 13B shows shoe 74 having a series of holes alongside its longitudinal opening 75. Two side by side holes of longitudinal opening 75 are marked as 76 and 77. Holes 78 and 79 are corresponding holes to holes 76 and 77 on the other side of longitudinal opening 75. Shoelace is marked as 80 and shoe zappy having holes 82, 83, 84, 85 and 86 is marked as 81. Holes 82 and 83 should be spaced apart by the mentioned specific distance. The same applies to holes 85 and 86. Shoelace 80 forms loop 87 between holes 82 and 83. Shoelace 80 then passes through holes 76,77, 78 and 79 as shown in figure 13A. Shoelace 80 then enters holes 85 and 86 of Shoe Zappy 81. Both ends of shoelace 80 then enter central hole 84 before passing underneath loop 87. Pulling ends 88 and 89 tightens the assembly. Untying is done by pushing Shoe Zappy 81 sidewise. To facilitate untying, complete loop 90 is formed and secured around loop 87 by element 91 as shown in figure 13B. Figure 13C shows a variation of the design. Here shoe zappy 81 has only 3 holes 82, 83 and 84. Shoelace 80 follows the path shown in figure 13C and after passing through holes 78 and 79, passes directly through central hole 84 of shoe zappy 81 before passing underneath loop 87. In these adaptations to wearables, only one hand is needed to loosen or tighten the assembly. Thus this adaptation is ideal for folks with one hand.

Figure 14A and 14B show yet two other variations of the design. Here holes used for forming loop1are shared by both ends of the ligature. In figure 14A, shoe 92 comprises of a longitudinal opening 93. Holes 94 and 95 are a pair of side by side hole alongside the edge of longitudinal opening 93. Holes 96 and 97 are corresponding side by side holes on the opposite side of longitudinal opening 93. Shoelace is 98. The frame or shoe zappy is 99. Shoe zappy 99 has 4 holes; 100,101, 102 and 103. Holes 101 and 102 should be spaced apart by the mentioned specific distance. Holes 100, 101 and 102 form a triangle. In a preferred practice, hole 103 is a mirror image of hole 100 with respect to an axis joining centers of holes 101 and 102. Shoelace 98 after criss-crossing through the holes alongside longitudinal opening 93, passes through hole 94. Shoelace 98 then forms loop 104 between holes 101 and 102 of shoe zappy 99. Shoelace 98, then, first passes through hole 95 of shoe 92, and next, passes through hole 100 of shoe zappy 99 before passing underneath loop 104. The other end of shoelace 98 interacts

the same way with holes on the opposite side of longitudinal opening 93 and then forms another loop 104 between holes 101 and 102. This design functions the same as other designs. The difference is that both ends of the shoelace 98 share holes 101 and 102 in forming loop 104. Figure 14B is a variation in the design where shoe zappy 99 has three holes 105, 106 and 107. Holes 105 and 106 should be spaced apart by the mentioned specific distance. Both ends of shoelace 98 form loops 108 between holes 105 and 106. Both ends of shoelace 98 then enter hole 107 before passing underneath loop 108 (only one such loop is shown in the figure). Both ends of shoelace 98 share holes 105, 106 and 107. Tightening and loosening is done as explained in conjunction with other designs. One may wish to form a complete loop around loops 108 as has been explained before.

Another use for this invention is in the design of ligature ladders. Introduction of methods of one-way clutching to the steps of a ligature ladder provides a system that is simple in structure and has a unique feature of being adjustable. Figure 15 shows formation of a ligature ladder using the 2-hole method. Parallel ligatures 109 and 110 and step elements 111 form a ligature ladder. Each of step elements 111 comprise of two holes 112 and 113 close to one end and holes 114 and 115 close to the other end. In a preferred practice, holes 112 and 113 should be spaced apart by the mentioned specific distance. The same applies to holes 114 and 115. Ligature 109 enters and exits holes 112 and 113 of step elements 111 in sequence forming loop 116 between holes 112 and 113. Ligature 109 then wraps around step element111 and passes underneath loop 116. Ligature 110 interacts with holes 114 and 115 in a similar fashion. The assembly procedure continues the same way with other step elements 111 to form an adjustable ligature ladder. Here adjustment is possible only in the upward direction. A force applied, in the upward direction to step elements causes the step elements to move upward relative to the ligature. However, relative motion between the ligatures and the step elements in the downward direction is impossible regardless of the magnitude of the force applied.

Figure 16A and 16B show formation of a ligature ladder using the loop turning method.

Here adjustment is total and is possible in both up or down directions. Element 117 forms one step of the ladder and two parallel ligatures 118 and 119 are the support ligatures. Element 117 comprises of two holes 120 and 121 close to one end and holes 122 and 123 close to the other end. In a preferred practice, holes 120 and 121 should be spaced apart by the mentioned specific distance. The same applies to holes 122 and 123. Ligature 118 passes through hole 120, then, forms a 1/2 turn loop 124 around step element 117, and then, passes through hole 121. The same arrangement is formed between ligature 119 and holes 122 and 123 as shown in the figure 16A. In this manner, element 117 can travel over the length of two parallel ligatures 118 and 119 in either direction up or down. Ligatures 118 and 119 then follow similar arrangement with other elements 117 to form a totally flexible ladder. To lock elements 117 at any position along the length of ligatures 118 and 119, the user simply rotates the 1/2 turn loops 124 around the edge of elements 117 from one side to the other side as shown in figure 16B. This simple loop turning provides a positive locking for elements 117 with respect to ligatures 118 and 119, in the downward direction. The reason becomes clear when figure 16B is studied. Turning the 1/2 turn loop from one side to the other forms an overlap between portions of the ligature thus, preventing any downward movement. The system works as a fully adjustable ladder. It is also possible to lock elements 117 with respect to ligatures 118 and 119 in the upward direction instead of the downward direction. To accomplish this, ligature 118 should enter hole 121 (instead of hole 120), then after forming the 1/2 turn loop, ligature 118 enters hole 120. Similarly, ligature 119 should enter hole 123 instead of hole 122. To make the design child proof, one may employ either an end cap or grooved path at either end of element 117. These safety measures are incorporated to make the turning of the 1/2 turn loop from one side to the other more involved. Also the use of proper identifiable markings (i.e. color coding) will help the user to visually establish if steps are in the locked position.

In either of the methods outlined above, relating to a flexible ladder, one can move the ladder steps freely, relative to the support ligatures, in at least one direction. Based on this observation, an ascending device comprised of only 4 step elements and 4 parallel

ligatures is designed. Figure 17 shows that parallel ligatures 125 and 126 and two elements 127 and 128 form half of the ascending device. The other half, which is set up side-by-side of the first half is formed by parallel ligatures 129 and 130 with step elements 131 and 132. Elements 127 and 128 interact with ligatures 125 and 126 using one of the one-way clutching methods. In a preferred practice, the loop turning method is the ideal choice for this application. Elements 131 and 132 interact with their respective ligatures 129 and 130 in a similar fashion. The climber will have one of his/her foot resting on element 128 and the other foot resting on element 132. Climber holds elements 127 and 131 in his/her hands. To climb up, the climber shifts his/her weight say to the left half of the ascending device and pulls and pushes elements 131 and 132 of the right half of the ascending device up relative to support ligatures 129 and 130. Then the climber shifts his/her weight to the right half and pulls and pushes up step elements 127 and 128 relative to support ligatures 125 and 126. By repeating this rhythmic motion, the climber moves his/her body along with the step elements up the support ligatures. Obviously, in order for the climber to pull elements 128 and 132 upward, climber's feet should be connected to elements 128 and 132. This is simply done by using a structure similar to a toe clip of bicycle pedals. To provide additional safety, strap means connect the body of the climber to the step elements. In this manner, if the climber's arms or legs get detached from the step elements, the strap means keep the climber connected to the ascending device.

A variation of the above mentioned ascending device comprises of only two ligatures and two step-elements. Each ligature connects to the center of a step element via one of the one-way clutching methods. The climber uses the mentioned rhythmic motion to climb.

In the above-mentioned ascending device, it is required that the climber shifts his/her weight from one side to the other side in order to climb. The reason being that the tension in the support ligatures translates into a resistance to movement by the step elements. This resistance can potentially be used to design an exercise device. Such device comprises of parallel ligatures, a frame, and rigid elements. The rigid elements

intermediate the parallel ligatures. The connection between the rigid elements and the ligatures follows one of the mentioned methods of one-way clutching. To change the resistance setting, the tension in the ligatures has to be adjusted. To change the ligature tension, one simply adjusts the ligatures at their connection to the frame.

The ascending devices outlined above can also be used as a descending device. A simple loop turning from one side to the other side conforms any "loop turning" ascending device into a descending device. The descendor who sits on a step element or sits on a seat hanging from the step elements, controls the rate of descent by holding the segments of the ligatures that are hanging below the step elements in his/her hands. Otherwise, a person at the ground level controls the rate of descent by exerting tension on the segments of the ligature that hangs below step elements. The control can be electromechanical or manual. It is also clear that forming more than 1/2 turn loop (i.e. see figure 7C) around step element causes the rate of descent to a slower setting.

The ascending devices outlined above can also be set up in the horizontal direction rather than in the vertical direction. Such device can be used over rivers, canyons, etc.

Figure 18 shows adaptation of the methods to power transmission. Here the assembly comprises of driver element 133, driven element 134, ligature 135 and frame 136. Driver element 133 can turn driven element 134 only in one direction, any attempt to turn the driver and driven elements in the opposite direction locks up the system as if a positive acting brake is applied. Conventional one-way clutches interact directly with either the driver or the driven element. However, in this invention, the one-way clutching element (i.e. frame 136) interacts directly with the power transmission ligature (i.e. ligature 135).

The vast potential of the methods of one-way clutching become more clear when further examples are studied. The invention can be used as a means for hanging pictures, bird feeders or plants; as a means for securing breathing mask to its ligature; as a means for securing buttons to clothing. The advantage being that the buttons can be

replaced at will. Another use for this invention is in bras. Here either each side of a bra cup function as a frame or a separate frame interfaces the cups and their connecting ligature. The methods can potentially be used in designing animal leach as well.

Claims

What I claim as my invention is:

Claim 1:

A device for creating a one-way clutching action between a ligature and a frame; said frame comprising of one or more sets of paired holes; in each said sets one hole of said paired holes being named hole1 and the other hole 2; said holes 1 and 2 having diameters approximately equal to the diameter or the width of said ligature; inner edge to inner edge distance between said holes1 and 2 being approximately equal to the diameter or the width of said ligature; one end of said ligature enters and exits said holes1 and 2 sequentially forming a ligature loop named loop1; said ligature end then forms a second loop around an edge of said frame before passing underneath said loop1; a relative motion between said frame and said ligature being possible only in one direction when tension is applied to said ligature ends; said frame having stepped structure along its boundaries creating a gap between said ligature and said frame; said gap providing space for user's fingers to hold and pull said ligature from underneath said loop1 for quick release or adjustment.

Claim 2:

A device for creating a one-way clutching action between a ligature and a frame; said frame comprising of one or more sets of three holes; said three holes in each said sets being named hole1, hole 2 and hole 3; inner edge to inner edge distance between said holes1 and 2 being approximately equal to the diameter or the width of said ligature; said holes 1 and 2 having diameters approximately equal to the diameter or the width of said ligature; in a preferred practice said holes 1, 2 and 3 form a triangle; one end of said ligature enters and exits said holes1 and 2 sequentially forming a ligature loop called loop1 ; said ligature end then enters and exits said hole 3 before passing underneath said loop 1; a relative motion between said frame and said ligature being possible in one direction by applying tension to said ligature end; to create a gap between said frame and said ligature, said frame comprises of an opening separating said holes 1 and 2 from said hole 3; or said hole 3 may be set at a higher elevation than

said holes1 and 2; said gap providing a space for user's fingers to hold said ligature to release or to adjust; said frame comprising of symmetric curvature on its boundaries.

Claim 3:

A ligature-frame assembly of claim 1or claim 2 in which said ligature end, after passing underneath said loop 1, forms a complete loop around said loop1 by passing underneath said loop1 a second time; securing means secure said complete loop around said loop1; pulling said complete loop upward loosens the lock formed between said frame and said ligature.

Claim 4:

A ligature-frame assembly of claim 1 or claim 2 in which said frame is a luggage carrier; including auto top luggage carriers; or a tent; or a tent peg; or a swing set; or a convertible top; or a cargo cover; or steps of a ligature ladder; or a belt; including seat belts; or a belt buckle; or pulling; lifting or towing devices.

Claim5:

A device for applying a one-way clutching action to wearables; said device comprising of a ligature and a frame; said wearable having a longitudinal opening with rows of holes alongside said longitudinal opening; said frame having 5 holes; a centrally positioned hole and holes 1, 2, 3, and 4; inner edge to inner edge distance between said hole 1 and hole 2 being approximately equal to the diameter or the width of said ligature; inner edge to inner edge of said hole 3 and hole 4 being approximately equal to the diameter or the width of said ligature; in a preferred practice, said holes 1 and 2 being mirror images of said hole 3 and 4 with respect to said centrally positioned hole; one end of said ligature after criss-crossing through all but the last hole of said wearable on its respective side enters and exits said holes 1 and 2 sequentially forming a loop named loop 1; said ligature end then enters and exits said last hole of said wearable on its respective side before entering and exiting said centrally positioned hole of said frame; said ligature end then passes underneath said loop1; ligature segment immediately out from under said loop 1 being named pull segment ; said ligature end then forms a complete loop around said loop 1 by passing underneath loop 1 for the second time; the other end of said ligature interacts with said holes 3 and 4 in

similar fashion; securing means secure said complete loop formed by one side of said ligature end to the said complete loop formed by the other end of said ligature; said wearable can be tighten by pulling said pull segments; said wearable can be loosened by pulling said securing means upward.

Claim 6:

A device for applying a one-way clutching action to wearables; said device comprising of a ligature and a frame; said wearable having a longitudinal opening; said wearable comprising of rows of holes alongside its longitudinal opening; said frame having 5 holes; a centrally positioned hole and holes 1, 2, 3, and 4; inner edge to inner edge distance between said hole 1 and hole 2 being approximately equal to the diameter or the width of said ligature; inner edge to inner edge of said hole 3 and hole 4 being approximately equal to the diameter or the width of said ligature; said holes 1 and 2 being a mirror images of said hole 3 and 4 with respect to said centrally positioned hole; one end of said ligature enters and exits said holes 1 and 2 sequentially forming a loop named loop 1; each of said ligature ends then enter and exit a hole on one side of said longitudinal opening of said wearable; said ligature ends then enter and exit corresponding holes alongside of the opposite side of said longitudinal opening of said wearable; one end of said ligature then enters and exits said hole 3; the other end of said ligature then enters and exits said hole 4; both said ligature ends then enter said centrally positioned hole before passing underneath said loop1; said ligature ends then form a complete loop around said loop1 by passing underneath said loop1 again; securing means secure said complete loop around said loop1; ligature segment just out from underneath of said loop1 being named pull segment; tightening is done by pulling said pull segment; loosening is done by sliding said frame sidewise.

Claim 7:

A device for applying a one-way clutching action to wearables; said device comprising of a ligature and a frame; said wearable having a longitudinal opening; said wearable comprising of rows of holes alongside its longitudinal opening; said frame being attached or being an integrated part of one side of said longitudinal opening of said wearable; said frame having 3 holes; said holes being holes 1, 2 and, 3; in a preferred practice, said 3 holes forming a triangle; inner edge to inner edge distance between said

holes 1 and 2 being approximately equal to the diameter or the width of said ligature; one end of said ligature enters and exits said holes 1 and 2 of said frame sequentially forming a loop named loop1; said ligature ends then each enter and exit a hole of said wearable; both said ligature ends then enter and exit hole 3 before passing underneath said loop1; said ligature ends then form a complete loop around said loop1 by passing underneath said loop1 again; securing means secure said complete loop around said loop1; tightening is done by pulling ligature segments immediately out from underneath said loop1; loosening is done by pulling said securing means upward.

Claim 8:

A securing means for pulling opposite sides of a wearable toward each other; said means composed of a wearable and ligatures; said wearable having a longitudinal opening; said wearable comprising of a row of holes along both sides of said longitudinal opening; each of said rows of holes comprising of sets of 3 holes; said 3 holes of each set being named hole 1, hole 2 and hole 3; in a preferred practice, said holes of each set forming a triangle; inner edge to inner edge distance between said holes 1 and 2 of each set being equal to the diameter or the width of said ligature; one end of a said ligature enters end exits holes 1 and 2 of a set forming a loop named loop1; said ligature end then enters and exits hole 3 of the same said set before passing underneath said loop1; said ligature end then forms a complete loop around said loop1 by passing underneath said loop1 again; securing means secure said complete loop around said loop1; the other end of said ligature interacts with a corresponding set of holes on the opposite side of said longitudinal opening; other ligatures being used to connect other sets of corresponding holes in the same fashion.

Claim 9:

A securing means for pulling opposite sides of a wearable toward each other; said means composed of a wearable and ligatures; said wearable having a longitudinal opening; said wearable comprising of a row of holes along either sides of its longitudinal opening; each of said rows of holes comprising of sets of 2 holes; said 2 holes of each set being named hole 1, hole 2; inner edge to inner edge distance between said holes 1 and 2 being approximately equal to the diameter or the width of said ligature; one end of said ligature entering and exiting said holes 1 and 2

sequentially thus forming a loop named loop1; said ligature end then forms a loop around the edge of the said longitudinal opening before passing underneath said loop1; said ligature end then forming a complete loop around said loop1 by passing underneath said loop1 again; securing means secure said complete loop around said loop1; other end of said ligature interact with a corresponding set of 2 holes on the opposite side of said longitudinal opening; other ligatures interact similarly with other sets of holes alongside the said longitudinal opening.

Claim 10:

A securing means for pulling opposite sides of a wearable toward each other; said means composed of a wearable and ligatures; said wearable having a longitudinal opening; said wearable comprising of a row of holes along either sides of its longitudinal opening; each of said rows of holes comprising of sets of 2 holes; said 2 holes of each set being named hole 1, hole 2; inner edge to inner edge distance between said holes 1 and 2 being approximately equal to the diameter or the width of said ligature; one end of said ligature entering and exiting said holes 1 and 2 sequentially thus forming a loop named loop1; said ligature ends then entering and exiting corresponding set of 2 holes on the opposite side of said longitudinal opening; both ends of said ligature then passing underneath said loop1; tightening is done by pulling ends of said ligature; loosening is done by pulling said ligature from underneath said loop1.

Claim 11:

A ligature ladder comprised of a set of parallel ligatures; said ligatures being intermediate by sets of bodies; said bodies, in a preferred practice, being round in shape and rigid; one end of said parallel ligatures being fastened at an elevation; the other end of said parallel ligatures being fastened to the ground level or left hanging free; in a preferred practice, each of said rigid bodies comprising of 4 holes; two holes being positioned close to one end of the said body and the two other holes being positioned close to the opposite end of the said body; one end of one of said ligatures enter and exits a hole close to one end of said rigid body; said ligature end then forms a ½ turn loop around said rigid body before entering and exiting from said second hole located at the same end of said rigid body; the other said ligature interacts with the

other end of said rigid body in the same fashion; other rigid bodies interact with the said parallel ligatures in same fashion; locking of said rigid bodies to said parallel ligatures is done by turning said ½ turn loop from one side to the other side over the corresponding end of said rigid bodies; said loop turning locks said rigid bodies to said ligatures in one direction.

Claim 12:

An ascending/descending device composed of a pair of long ligatures, a pair of rigid bodies and a pair of short ligatures; each of the said rigid bodies having 3 sets of paired holes; one of said paired holes being centrally located; the other said paired holes being located close to one and the last paired holes being located close to the other end of said rigid body; one end of one of said short ligatures enter and exits said two holes located close to one end of one of said rigid bodies sequentially forming a loop; said ligature end then passes underneath said loop after forming a ½ turn loop around said rigid body; the other end of said short ligature interacts similarly with the pairs of holes located at the other end of said rigid body; one of said long ligatures being fastened at one end to an elevation; the other end of said long ligatures enters and exits one of said centrally located holes of said rigid body; said ligature end then forms a ½ turn loop around said rigid body before entering and exiting the second centrally located hole of the said rigid body; the other said long ligature, short ligature and rigid body interact with each other in a similar fashion; when ascending the said ½ turn loop of said long ligatures is turned from one side to the other; said loop turning causes a one-way locking between said long ligature and said rigid body; when descending, said ½ turn loop is turned back to its original position.

Claim 13:

A one-way power transmission apparatus composed of a driver element, a driven element, a power transmitting ligature and, a stationary frame; said ligature transferring power from said driver to said driven element; said stationary frame having sets of 3 holes; said holes being named holes 1, 2 and 3; inner edge to inner edge distance between said holes 1 and 2 being approximately equal to the diameter or the width of said ligature; said ligature forming a loop between said holes 1 and 2; said ligature after

passing through said hole 3 passes underneath said loop; said ligature connecting said driven and said driver elements.

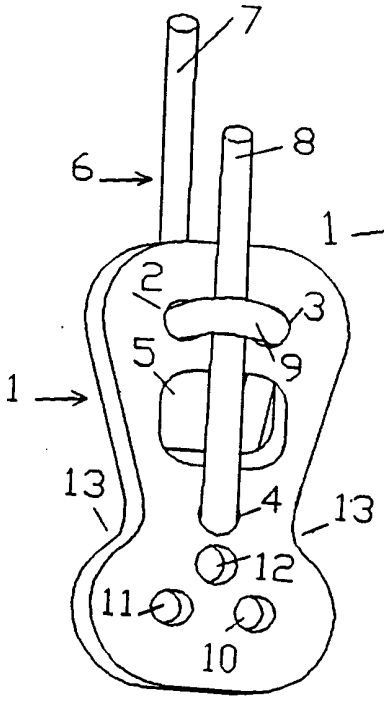

FIG 1

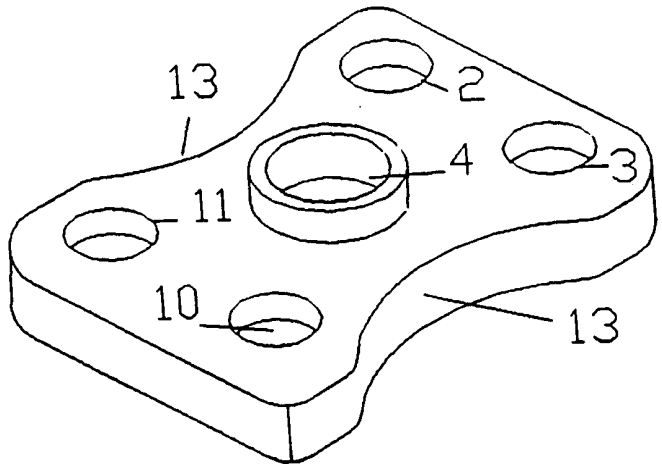

FIG 2

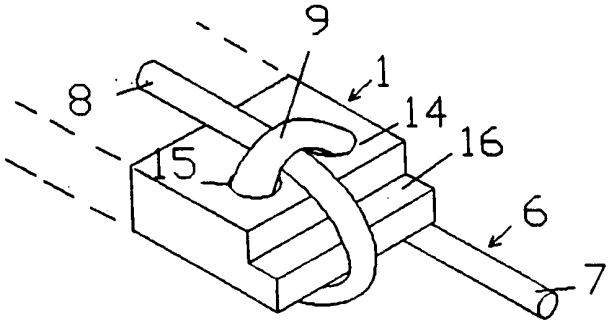

FIG 3

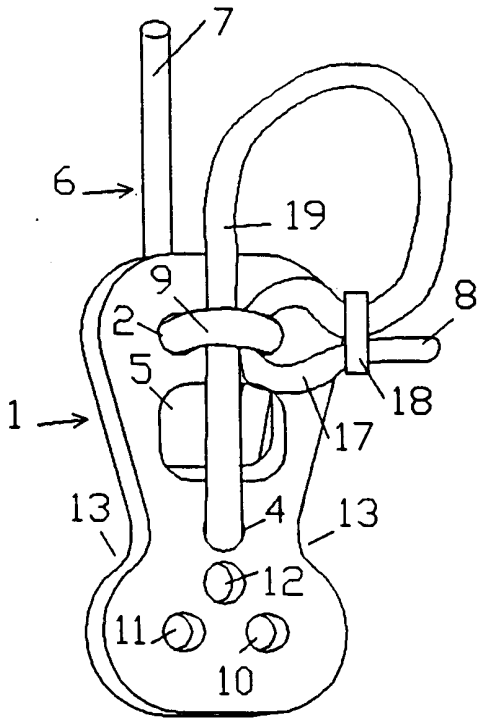

FIG 4

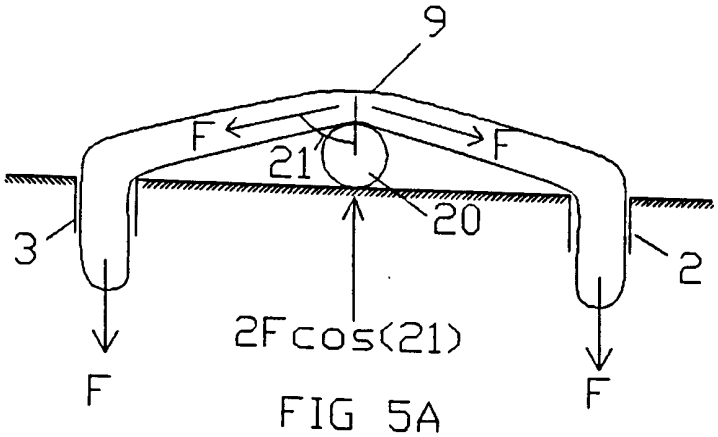

FIG 5A

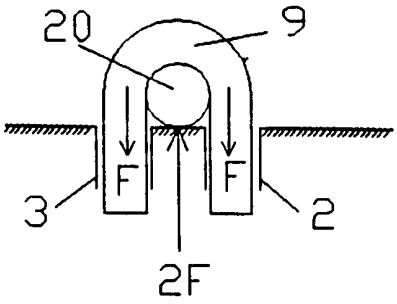

FIG 5B

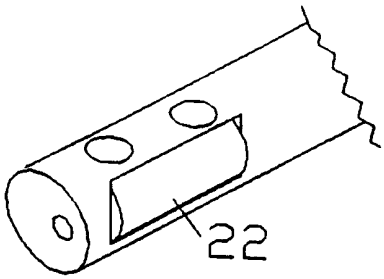

FIG 6A

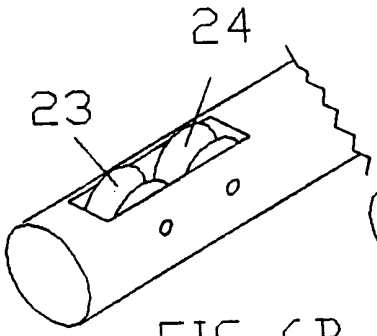

FIG 6B

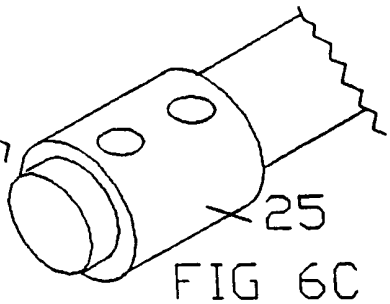

FIG 6C

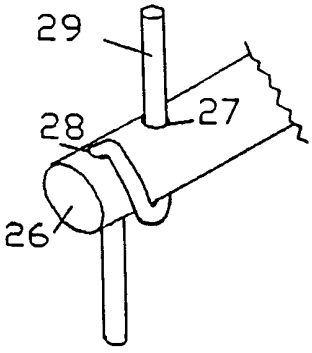

FIG 7A

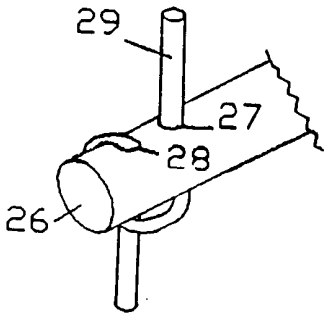

FIG 7B

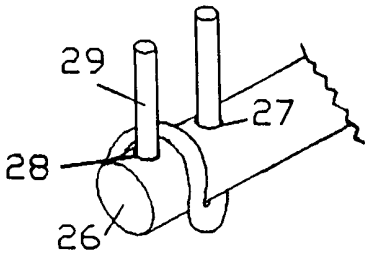

FIG 7C

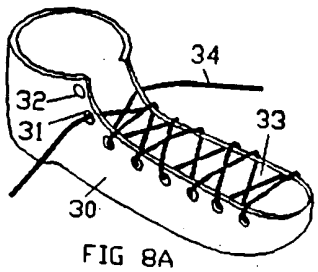

FIG 8A

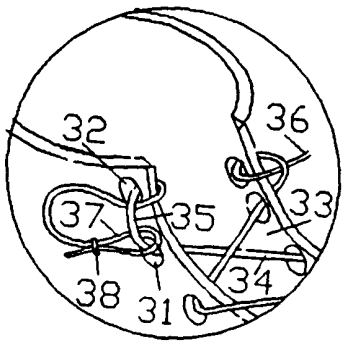

FIG 8B

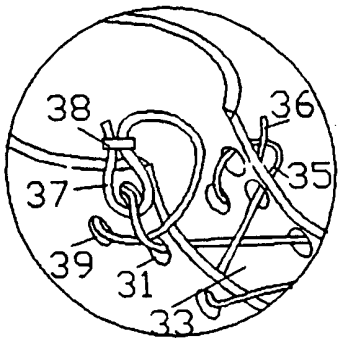

FIG 9B

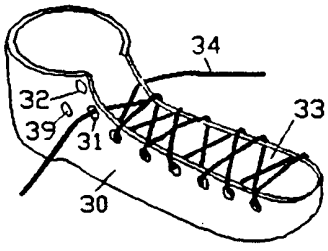

FIG 9A

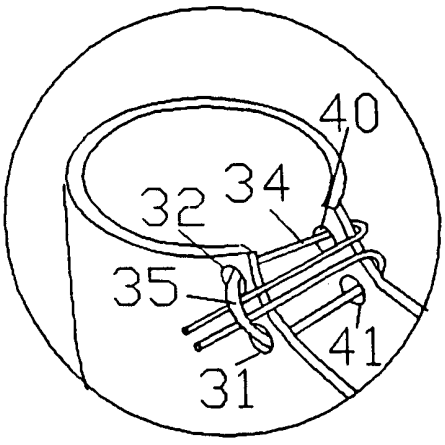

FIG 10

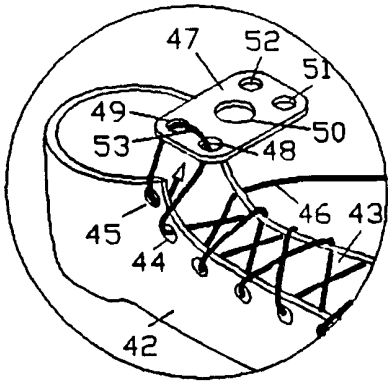

FIG 11A

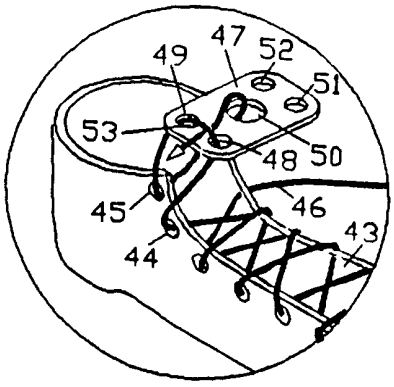

FIG 11B

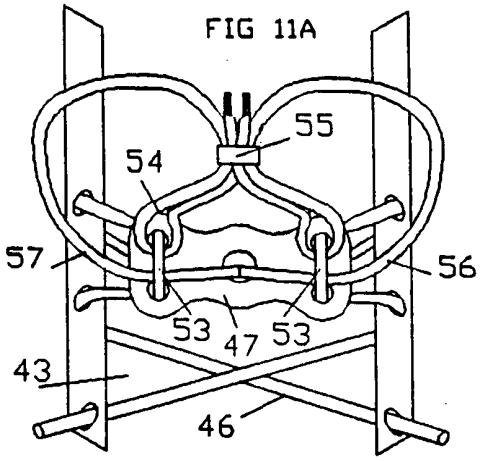

FIG 11C

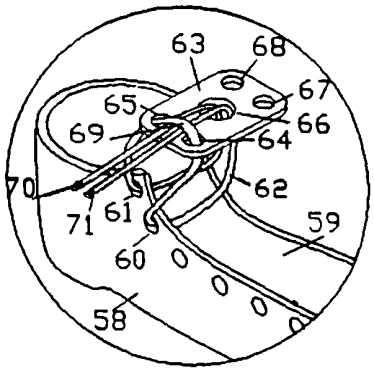

FIG 12A

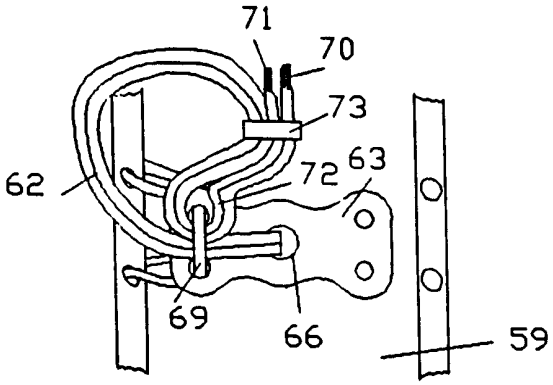

FIG 12B

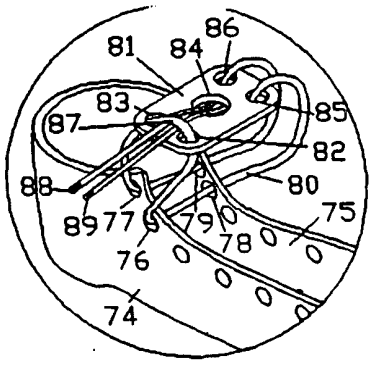

FIG 13A

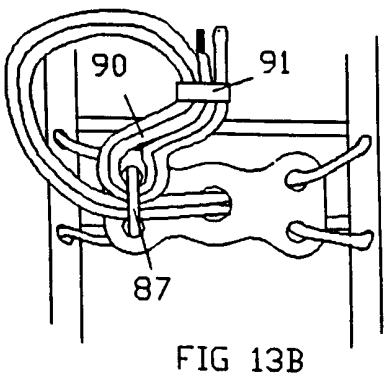

FIG 13B

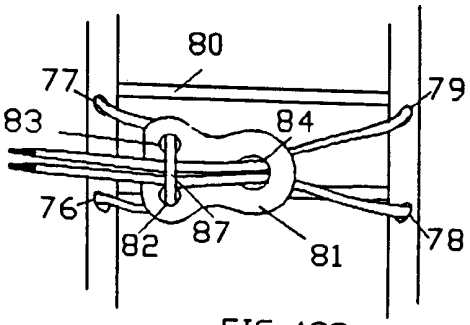

FIG 13C

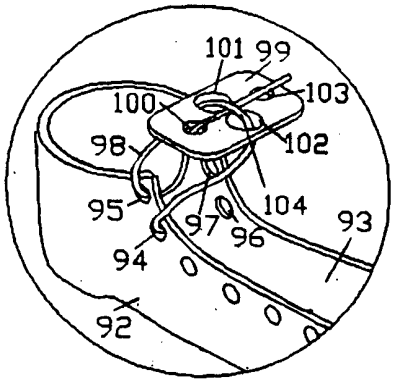

FIG 14A

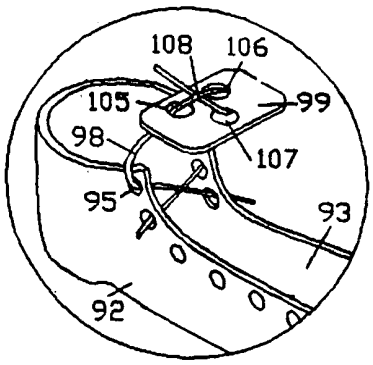

FIG 14B

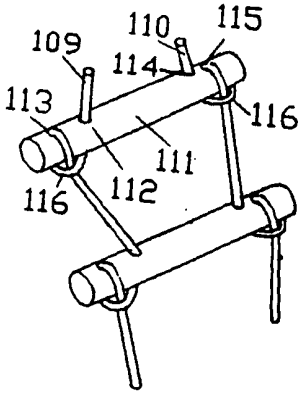

FIG 15

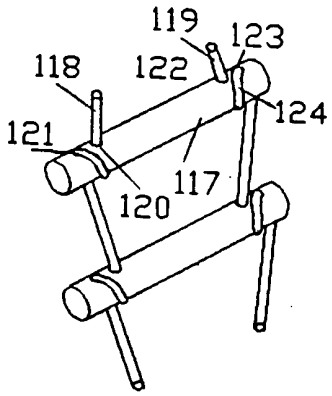

FIG 16A

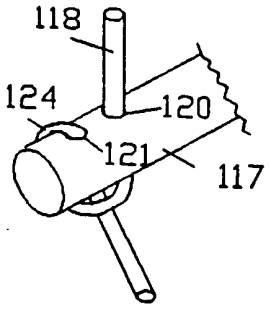

FIG 16B

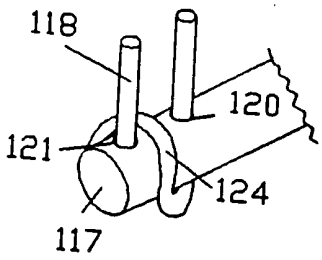

FIG 16C

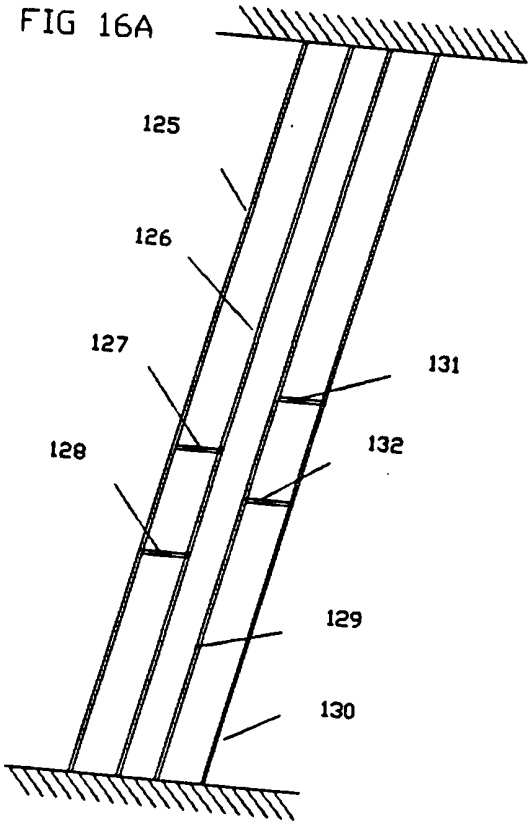

FIG 17

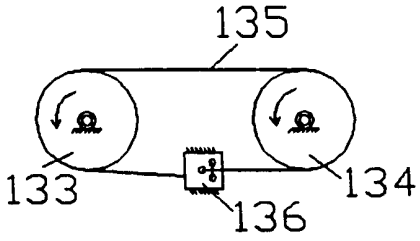

FIG 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/20201

A. **CLASSIFICATION OF SUBJECT MATTER**
IPC(7) :A43C 7/00, F16G 11/00, A44B 21/00,
US CL :24/129R, 115H, 129A, 131C, 712.1, 713.6, 712.9, 122.6
According to International Patent Classification (IPC) or to both national classification and IPC

B. **FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 24/129R, 115H, 129A, 131C, 712.1, 713.6, 712.9, 122.6, 129B, 66.9, 300,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. **DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,351,367 A (KENNEDY ET AL) 04 OCTOBER 1994 (04/10/94), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 4,261,081 A (LOTT) 14 APRIL 1981 (14/04/81), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 0,532,242 A (McSHANE) 08 JANUARY 1895 (08/01/95), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 3,276,083 A (GUBASH) 04 OCTOBER 1966 (04/10/66), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 2,932,072 A (PRUCHNOW) 12 APRIL 1960 (12/04/60), SEE THE ENTIRE DOCUMENT .	1 - 13

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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

Date of the actual completion of the international search 02 FEBRUARY 2000	Date of mailing of the international search report 14 FEB 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer VICTOR SAKRAN Telephone No. (703) 308-2224

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/20201

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,293,675 A (SHAI) 15 MARCH 1994 (15/03/94), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 3,675,276 A (NUSE) 11 JULY 1972 (11/07/72), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 0,749,235 A (SMITH) 12 JANUARY 1904 (12/01/04), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 0,987,407 A (SCOTT) 21 MARCH 1911 (21/03/11), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 0,903,240 A (SMITH) 10 NOVEMBER 1908 (10/11/08), SEE THE ENTIRE DOCUMENT .	1 - 13
.	..	
Y	US 1,665,745 A (LANG) 10 APRIL 1928 (10/04/28), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 0,329,071 A (PALMER) 27 OCTOBER 1885 (27/10/85), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 5,065,482 A (LOFY) 19 NOVEMBER 1991 (19/11/91), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	US 3,631,570 A (COLEMAN) 04 JANUARY 1972 (04/01/72), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	GB 0,342,153 A (HAHN) 29 JANUARY 1931 (29/01/31), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	GB 2,028,417 A (LOOMIS) 05 MARCH 1980 (05/03/80), SEE THE ENTIRE DOCUMENT .	1 - 13
Y	CH 0,305,913 A (BOLLIGER) 15 MARCH 1955 (15/03/55), SEE THE ENTIRE DOCUMENT .	1 - 13