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(54) **LOCKING MECHANISMS FOR USE WITH DEVICES FOR FORMING A CLOSURE BETWEEN MATERIALS**

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(60) Provisional application No. 60/866,427, filed on Nov. 19, 2006.

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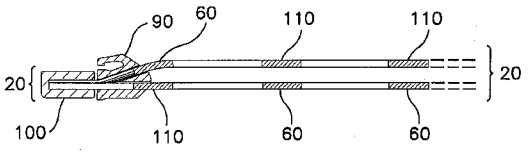
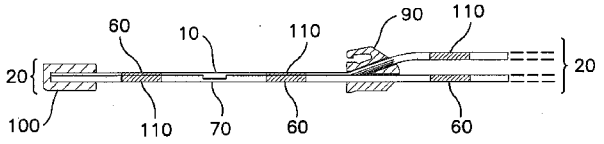
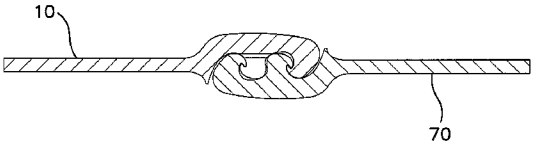
(57) **ABSTRACT**

A waterproof fastening device is provided. The fastening device includes a first fastening member and second fastening member, both having mating surfaces that include rails and channels therein. The fastening devices further include mateable openings and projections therein that cooperate to impart a waterproof seal that is resistant to pull-out.







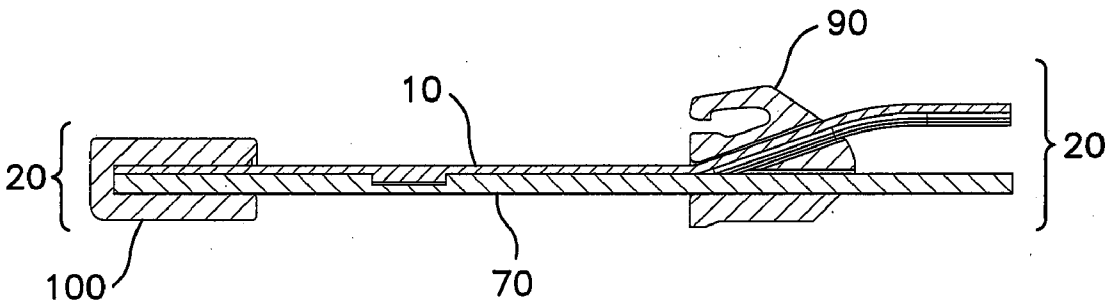


FIG. 1

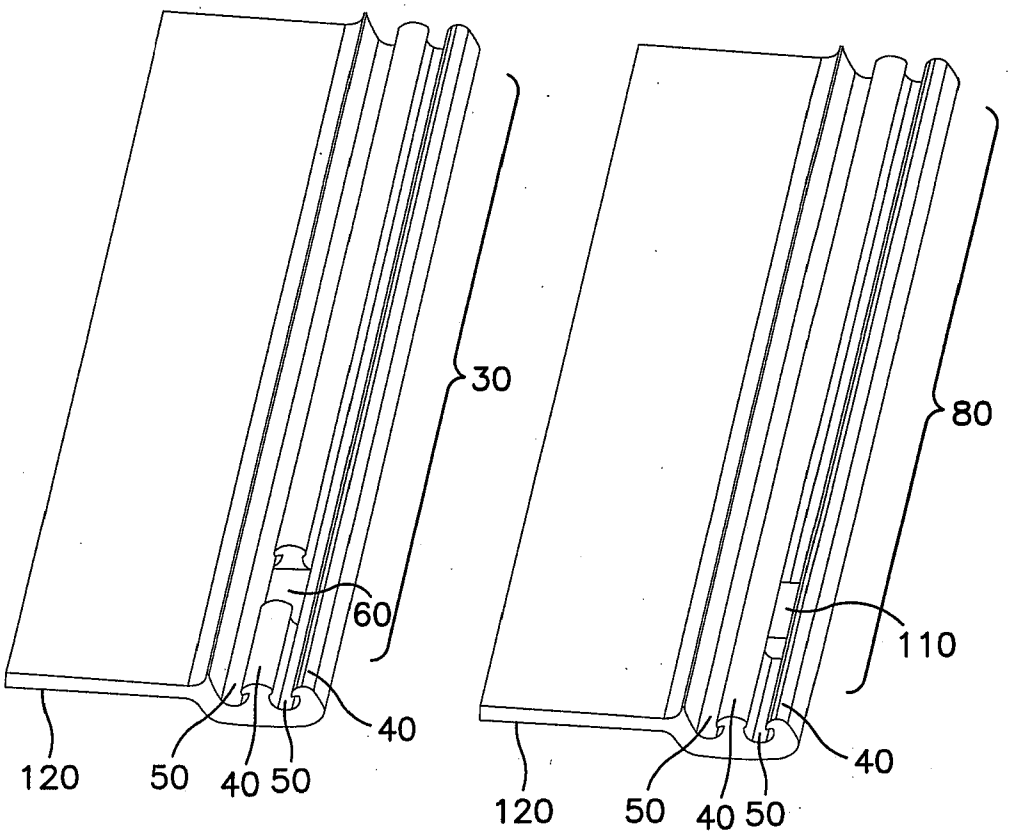


FIG. 2

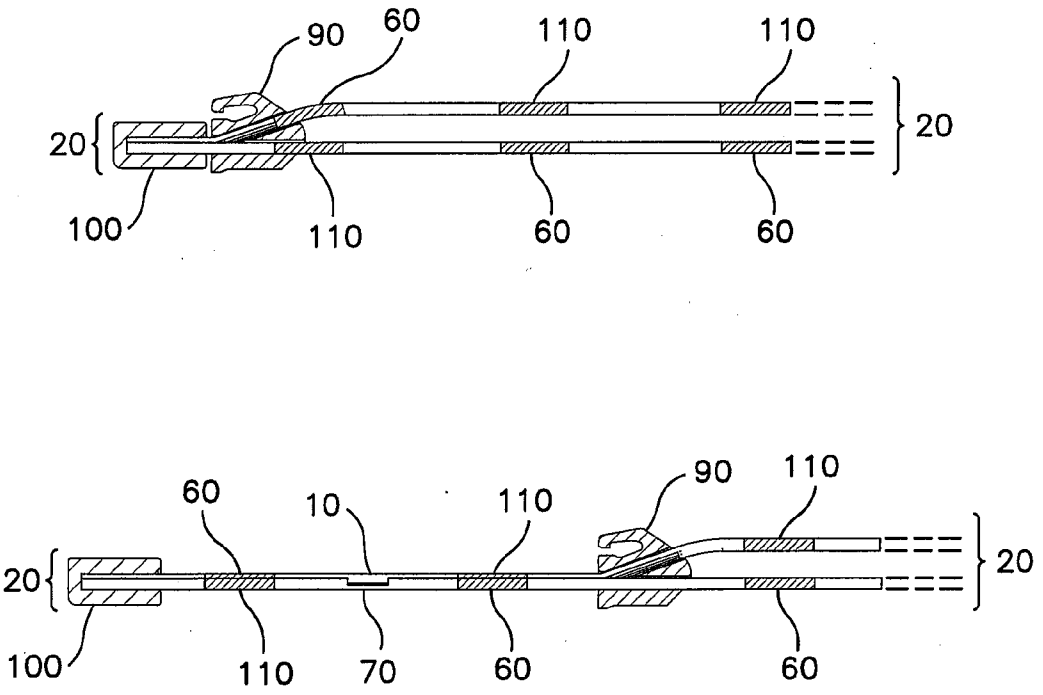

90
60
110
110
20
20
100
110
60
60
60
10
110
90
110
20
20
100
110
70
60
60

FIG. 3

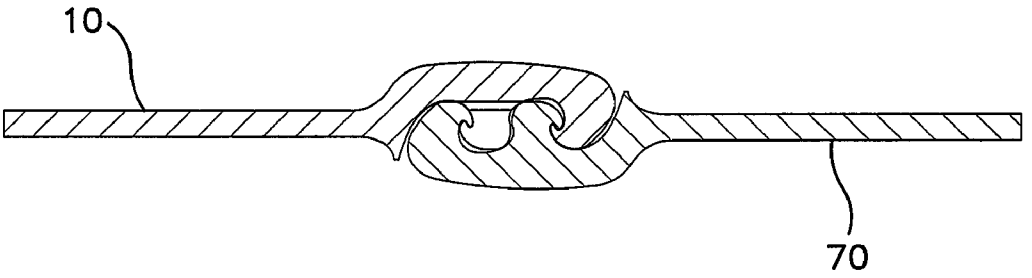


FIG. 4

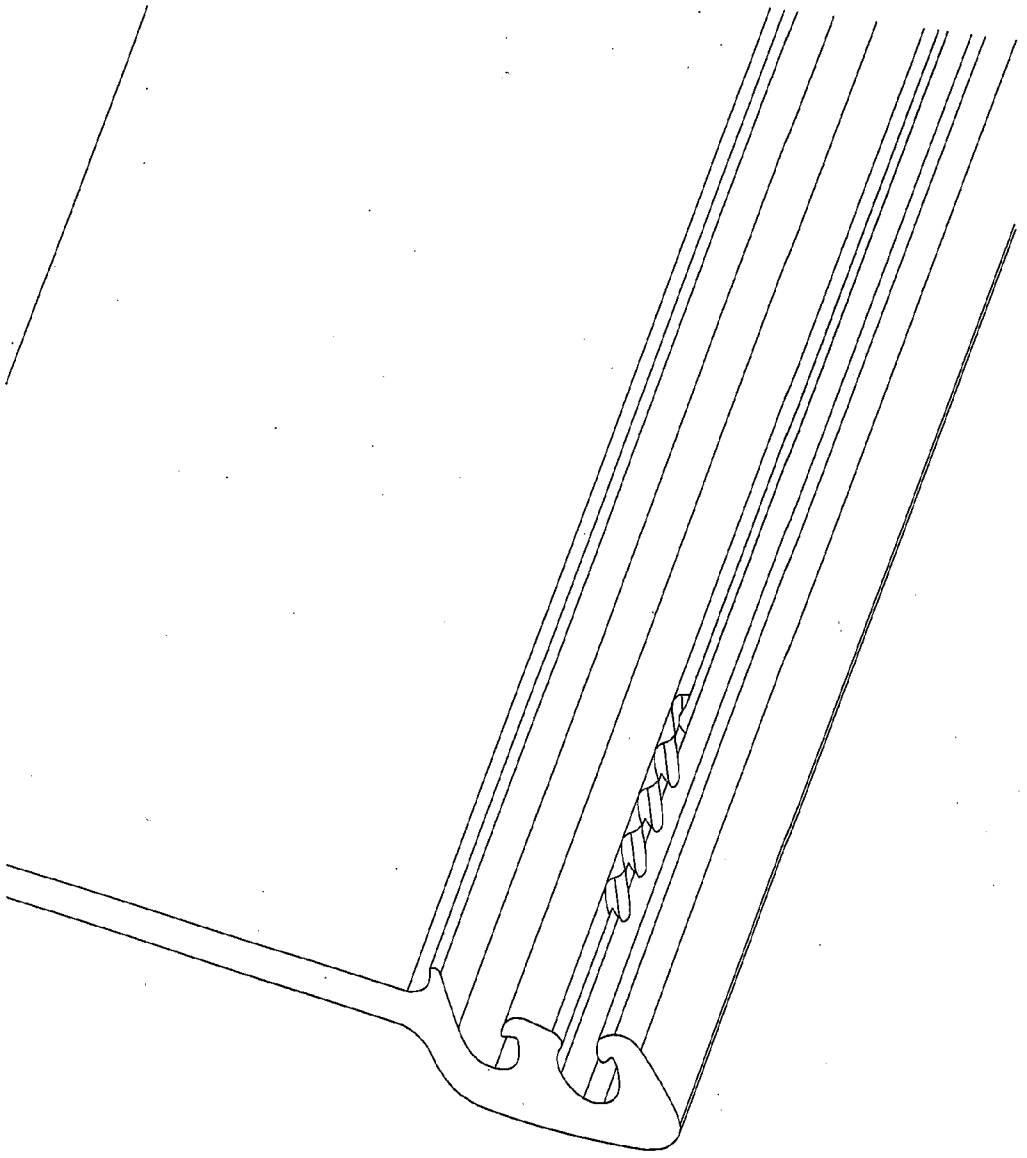


FIG. 5

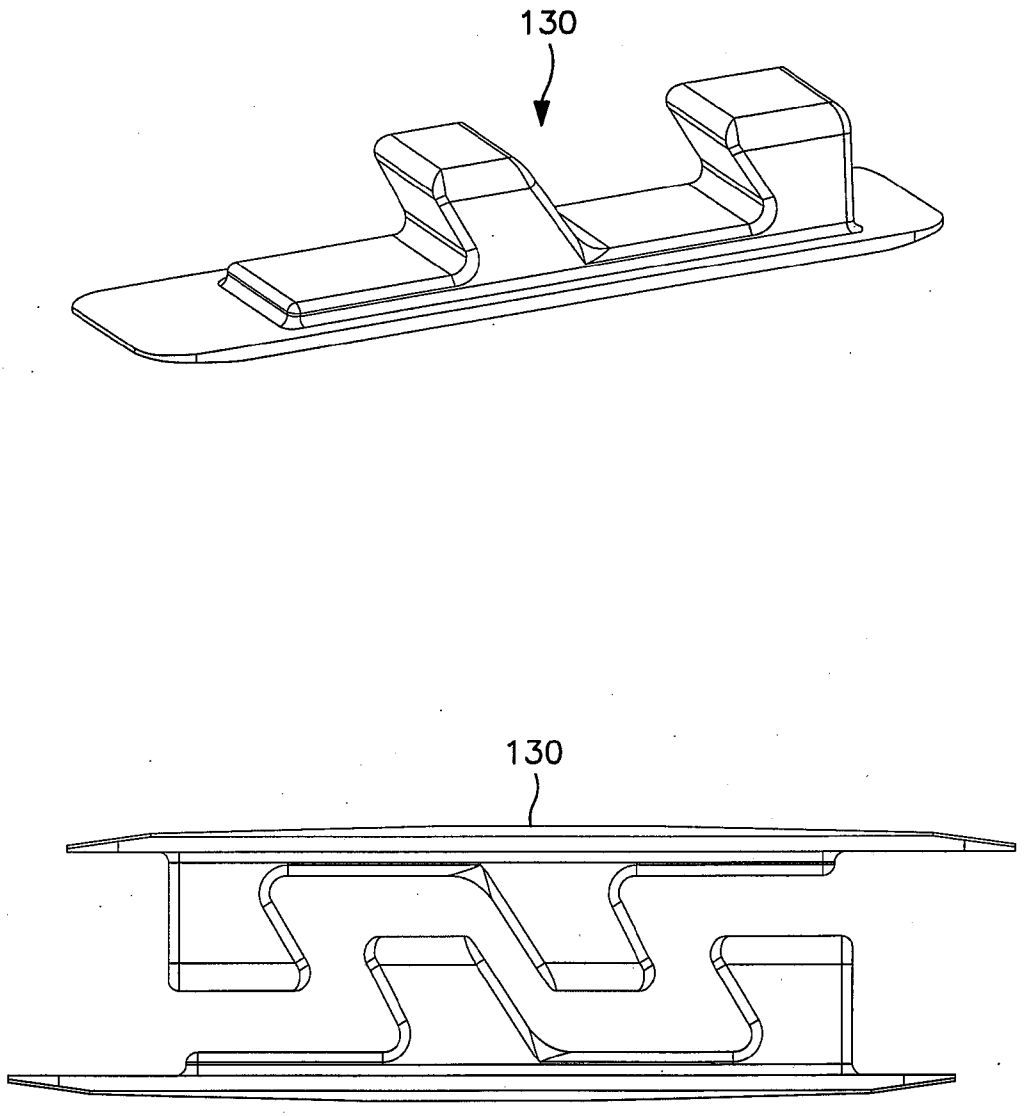


FIG. 6

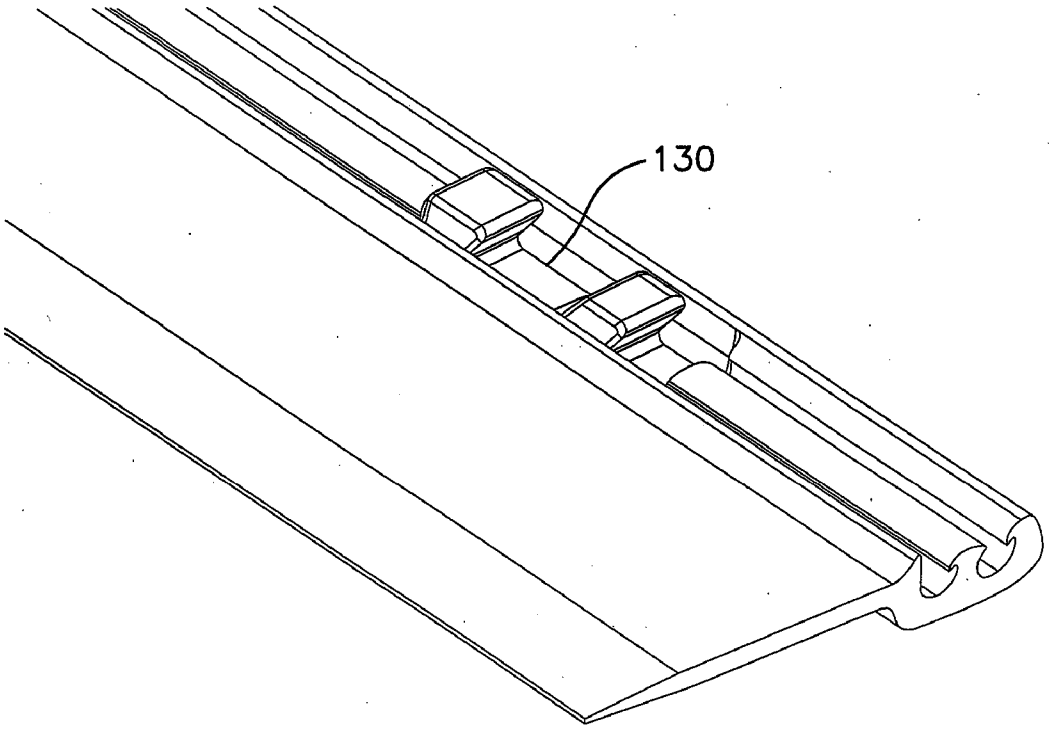


FIG. 7

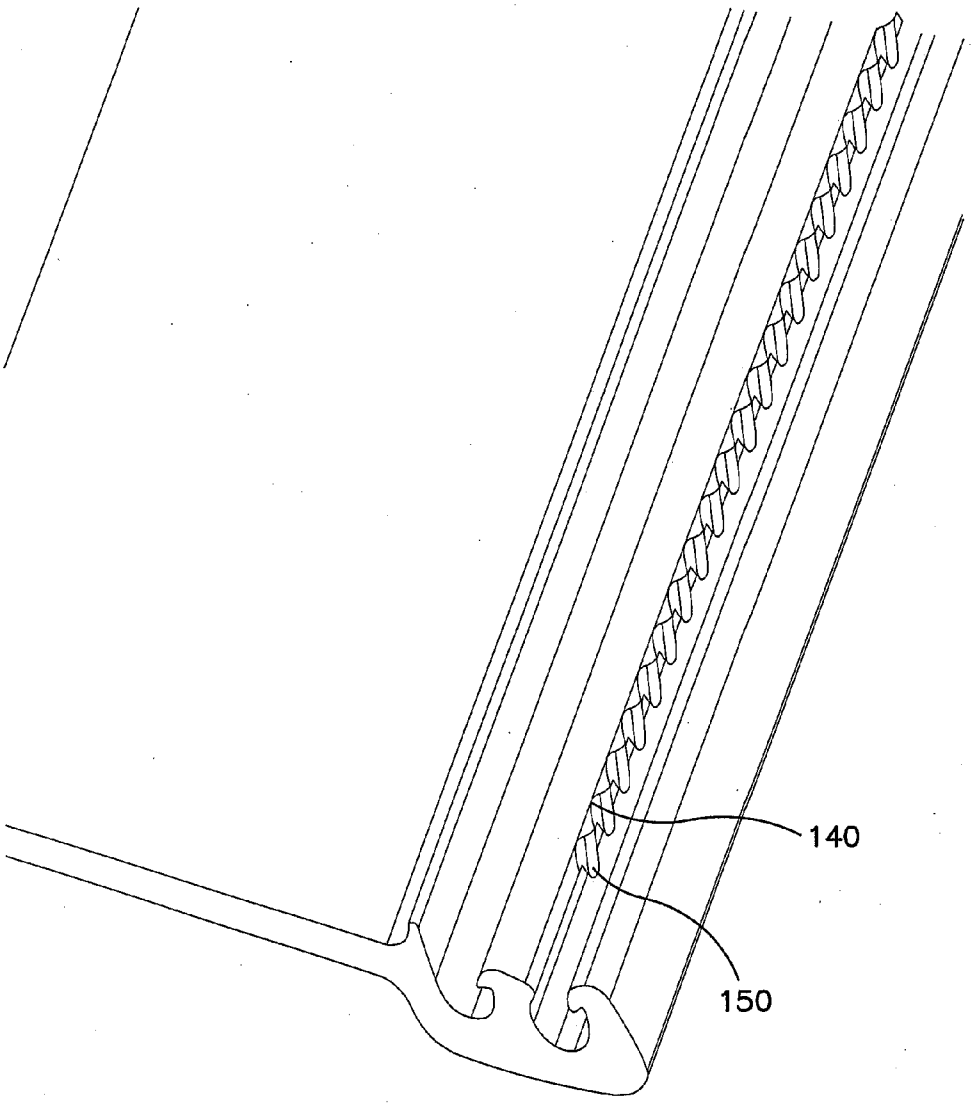


FIG. 8

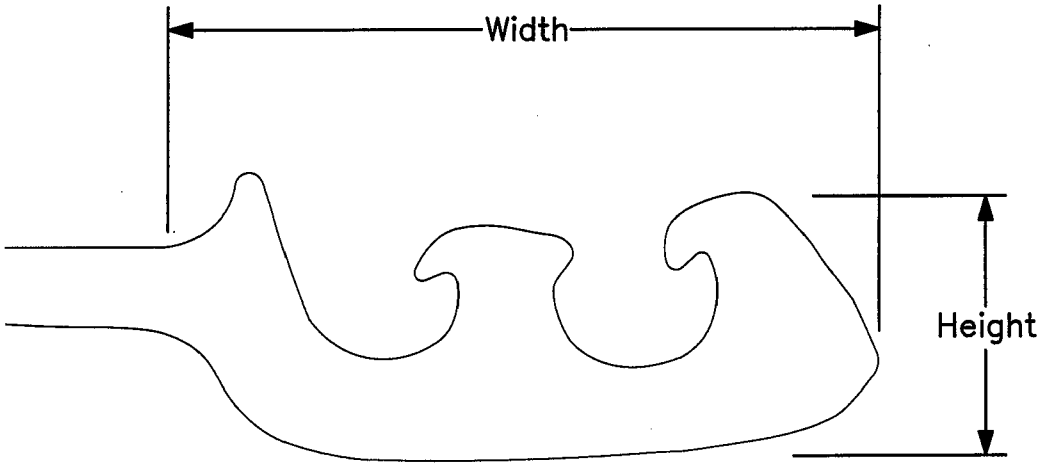
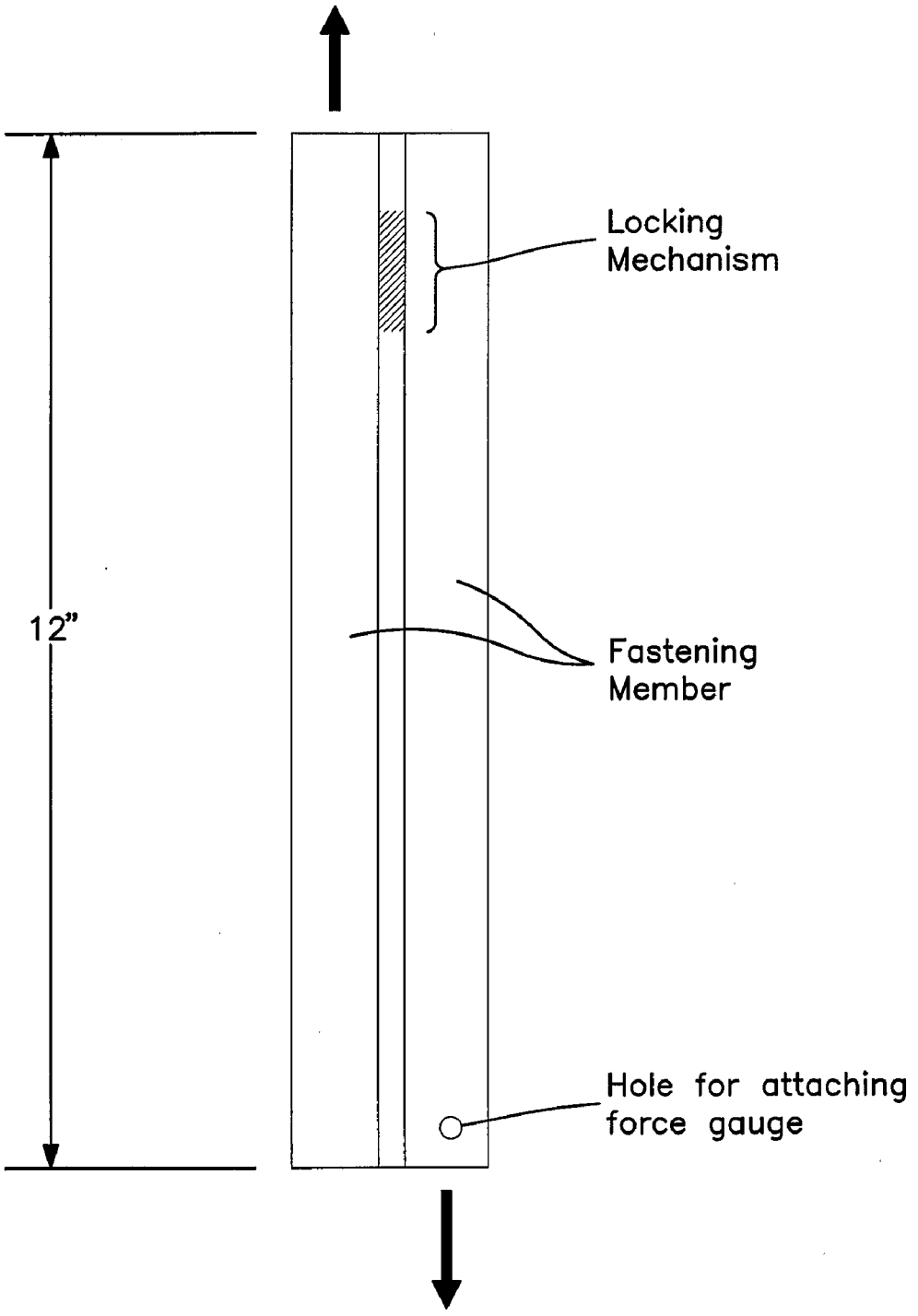


FIG. 9



Holding Force Test Method

FIG. 10

LOCKING MECHANISMS FOR USE WITH DEVICES FOR FORMING A CLOSURE BETWEEN MATERIALS

RELATED APPLICATION

[0001] The present application is a continuation-in-part application of pending U.S. patent application Ser. No. 11/942,555 filed Nov. 19, 2007, and further claims the benefit of U.S. Provisional Application No. 60/866,427 filed Nov. 19, 2006.

BACKGROUND

[0002] Fastening devices typically include two flexible elongated components having teeth (i.e zippers) which are forced to interlock and separate by moving a slide along the components. Although such fastening devices have long been used to close and open various articles, such as clothing and bags, such devices suffer from the allowance of liquids and gases within the fastener, and are therefore not useful for conditions in which a wind-proof, gas-tight and/or waterproof article is desirable.

[0003] In response to the short comings of the above described devices, fastening devices having mating surface with rails that interlock to form fluid tight closures have been developed. In some constructions (such as jackets), these fastening devices are generally inserted into a bottom stop to hold the interlocked rails in place and prevent them from sliding upon each other during use. Although, these devices are highly useful in applications which require protection from wind and water, the devices may experience pull-out during use. That is, the rails may disengage from the bottom stop or slide past each other when a force parallel to the axis of the rails is applied.

[0004] In order to prevent pull-out of the rails, the opening in the bottom stop has been previously made smaller to facilitate a snugger fit of the rail into the bottom stop. This, however, may make it difficult to insert the rail into the bottom stop in the first place.

[0005] Thus, there remains a need for a fastening device that is waterproof and that is constructed in a manner that decreases the likelihood of pull out while maintaining ease of use of the fastening device.

SUMMARY OF INVENTION

[0006] A waterproof fastening device having interlocking mating surfaces is described. The fastening device includes a first fastening member (**10**) having two opposing ends (**20**). The first fastening device also includes a first mating surface (**30**) having a plurality of rails (**40**) having channels (**50**) there between, wherein at least one of the plurality of rails comprises an opening (**60**).

[0007] The waterproof fastening device also includes a second fastening member. The second fastening member (**70**) has two opposing ends (**20**) and further has a second mating surface (**80**) having a plurality of rails (**40**) with channels (**50**) there between. The second mating surface (**80**) is adapted for operatively engaging the first mating surface (**30**) to facilitate the formation of a waterproof seal. Further, at least one of the channels (**50**) has a projection (**110**) which is adapted to engage the opening (**60**) in the plurality of rails when the first mating surface (**30**) and the second mating surfaces (**80**) are operatively engaged.

[0008] The waterproof fastening device also includes a slider (**90**) engageable and movable along the first and said second mating surfaces. In this regard, the slider is adapted for forming and maintaining a waterproof seal between said first and said second mating surfaces.

[0009] The waterproof fastening device may also include a stop block (**100**) fixedly connected to one end of the two opposing ends of the first fastening member or the second fastening member. The stop block is adapted to house one end of the first fastening member and the second fastening member when the first mating surface and the second mating surface are operatively engaged.

[0010] In an embodiment of the invention, the projection is positioned closer to the end having a stop block fixedly connected thereto than to said opposing end. Additionally, the projection desirably possesses the same shape as the opening or openings. Desirably, the opening is the shape of a circle, trapezoid, triangle, square, rhombus, rectangle, or the like. Alternatively, the opening is a series of repeating geometries and/or repeating alternating geometries.

[0011] Another aspect of the invention addresses a waterproof fastening device having a first fastening member (**10**) having two opposing ends (**20**). The first fastening device also includes a first mating surface (**30**) having a plurality of rails (**40**) having channels (**50**) there between, wherein at least one of the plurality of rails comprises multiple openings (**60**).

[0012] The waterproof fastening device also includes a second fastening member. The second fastening member (**70**) has two opposing ends (**20**) and further has a second mating surface (**80**) having a plurality of rails (**40**) with channels (**50**) there between. The second mating surface (**80**) is adapted for operatively engaging the first mating surface (**30**) to facilitate the formation of a waterproof seal. Further, at least one of the channels (**50**) has multiple projections (**110**) which is adapted to engage the multiple opening (**60**) in the plurality of rails when the first mating surface (**30**) and the second mating surfaces (**80**) are operatively engaged.

[0013] Yet another aspect of the invention addresses a waterproof fastening device having a first fastening member (**10**) having two opposing ends (**20**). The first fastening device also includes a first mating surface (**30**) having a plurality of rails (**40**) having channels (**50**) there between.

[0014] The waterproof fastening device also includes a second fastening member. The second fastening member (**70**) has two opposing ends (**20**) and further has a second mating surface (**80**) having a plurality of rails (**40**) with channels (**50**) there between. The second mating surface (**80**) is adapted for operatively engaging the first mating surface (**30**) to facilitate the formation of a waterproof seal.

[0015] The fastening device also includes at least one interlocking protuberance positioned in communication with the mating surface of the first fastening member and at least one interlocking protuberance **130** in communication with the mating surface of the second fastening member wherein the at least one interlocking protuberance positioned in communication with the mating surface of the first fastening member and the at least one interlocking protuberance in communication with the mating surface of the second fastening member are adapted to interlock with each other when said first mating surface and said second mating surface are operatively engaged.

[0016] Yet another aspect of the invention addresses a waterproof fastening device having a first fastening member having two opposing ends. The first fastening device also

includes a first mating surface having a plurality of rails having channels there between.

[0017] The waterproof fastening device also includes a second fastening member. The second fastening member has two opposing ends and further has a second mating surface having a plurality of rails with channels there between. The second mating surface is adapted for operatively engaging the first mating surface to facilitate the formation of a waterproof seal.

[0018] Desirably, the first fastening member and second fastening member do not pull-out when between about 10 up to about 200 Newtons or about 10 up to about 90 Newtons of force is applied using the holding force test.

[0019] Yet another aspect of the invention addresses a waterproof fastening device having a first fastening member having two opposing ends. The first fastening member also includes a high coefficient of friction first mating surface having a plurality of rails having channels there between.

[0020] The waterproof fastening device also includes a second fastening member. The second fastening member has two opposing ends and further has a high coefficient of friction second mating surface having a plurality of rails with channels there between. The second mating surface is adapted for operatively engaging the first mating surface to facilitate the formation of a waterproof seal.

[0021] Yet another aspect of the invention addresses a waterproof fastening device having a first fastening member having two opposing ends and a first mating surface. The first mating surface has a plurality of rails having a plurality of depressions and peaks thereon.

[0022] The waterproof fastening device also includes a second fastening member. The second fastening member has two opposing ends and a second mating surface and further has a plurality of rails having a plurality of depressions and peaks thereon. The depressions and peaks of the first mating surface are adapted to interlock with the depressions and peaks of the second mating surface to prevent pull-out. Further, the second mating surface is adapted for operatively engaging the first mating surface to facilitate the formation of a waterproof seal.

BRIEF DESCRIPTION OF DRAWINGS

[0023] FIG. **1** is a perspective view of a fastening device having a first fastening member, a second fastening member, and a slider.

[0024] FIG. **2** is a perspective view of a first mating surface having an opening and a second mating surface having a projection.

[0025] FIG. **3** is perspective view of fastening devices having multiple projections and openings.

[0026] FIG. **4** is a perspective and cross-sectional view of a first fastening member interlocked with a second fastening member.

[0027] FIG. **5** is a perspective view of a side oriented locking mechanism component.

[0028] FIG. **6** is a perspective view of an interlocking protuberance.

[0029] FIG. **7** is a perspective view of an interlocking protuberance seated inside a fastening member.

[0030] FIG. **8** is perspective view of a fastening member having depressions and peaks.

[0031] FIG. **9** is a perspective view of a fastening member defining height of the fastening member and width of the mating surface.

[0032] FIG. **10** is an illustration of the holding force test.

DETAILED DESCRIPTION

[0033] Fastening devices for creating and maintaining a seal are described herein. The devices of the present invention utilize various constructions for preventing mating surfaces from sliding past each other or pulling out during use. These constructions include, for example, projection/opening combinations, interlocking protuberances, high coefficient of friction mating surfaces, and depression/peak combinations.

[0034] The invention will be described with reference to the following description and figures which illustrate certain embodiments. It will be apparent to those skilled in the art that these embodiments do not represent the full scope of the invention which is broadly applicable in the form of variations and equivalents as may be embraced by the claims appended hereto. Furthermore, features described or illustrated as part of one embodiment may be used with another embodiment to yield still a further embodiment. It is intended that the scope of the claims extend to all such variations and embodiments.

[0035] It should be noted that any given range presented herein is intended to include any and all lesser included ranges. For example, a range of from 45-90 would also include 50-90; 45-80; 46-89 and the like. Thus, for example, the range of 95% to 99.999% also includes, for example, the ranges of 96% to 99.1%, 96.3% to 99.7%, and 99.91 to 99.999%.

[0036] Referring initially to FIGS. **1-3**, a perspective view of the fastening device is shown. The fastening device includes a first fastening member **10**, a second fastening member **70** and a slider **90**. The fastening device creates a seal along the entire length of the first fastening member **10** and second fastening member **70**. When the fastening device is unsealed, an opening exists between first fastening member **10** and second fastening member **70**, thereby providing access to the space to the interior of the seal.

[0037] In use, a seal is formed by sliding the slider **90** down the length of the fastening member which causes the slider **90** to interlock the mating surface **30** of the first fastening member **10** with the mating surface **80** of the second fastening member **70**. In this regard, the slider is moved in a direction causing the first fastening member and the second fastening member to pass within the slider from the opening end **20** to the closing end **20**. The slider confines the first mating surface into contact with the second mating surface thereby creating a seal. As such, the fastening device bears similarity to a zipper, whereby the user of the fastening device manipulates the slider **90** to facilitate the formation of the seal, and also manipulates the slider **90** to unseal the fastening device and gain access to the interior of the seal. Alternatively, the fastening members may interlock without the use of a slider. In this regard, the fastening members of the fastening device may by manually coupled. Regardless of how the seal if formed, the fastening devices currently described, unlike conventional zippers, do not utilize teeth and are generally waterproof. The property of waterproofness is described below.

[0038] Referring now to FIGS. **2** and **4**, a perspective view of the first fastening member **10** and second fastening member **70** is shown without the slider present. FIG. **4** clearly illustrates that, if desired, first fastening member **10** may be reversed relative to second fastening member **70**. That is, FIG. **4** illustrates that first fastening member **10** extends to the left of the page, while the second fastening member **70** extends to

the right of the page. Conversely, the first fastening member **10** may extend in a reverse direction, that is, to the right of the page, while the second fastening member **70** may extend to the left of the page. Therefore, waterproof fastening device can be configured to provide access from either direction to the interior of the article to which it is attached. Of course, if the seal is sufficiently long, when unsealed, the first fastening member **10** may be moved away from second fastening member **70** to provide extensive access from any direction to the interior of the article to which device **10** is attached.

[0039] It is appropriate to utilize materials of sufficient dimension and material type such that the fastening device may be incorporated into a variety of different objects incorporating fabrics or other laminate materials (which may be waterproof or non-waterproof), such as wet suits, waders, rain gear, marine apparel, and boots, to name but a few. Accordingly, the first fastening member desirably includes a sufficient width of runout material **120** such that it may be permanently attached to an object, such as, for example, a clothing article, to form one side of the seal on the object. Similarly, the second fastening member **70** also includes a sufficient width of runout material **120** such that it too may be permanently attached to an object to form a second side of the seal for the object.

[0040] The first fastening member **10** and second fastening member **70** are made of resilient material that is capable of interlocking to form a seal. The first fastening member and second fastening member can be made of the same or different resilient materials utilizing extrusion, casting or other methods known in the art. Such materials may include, but are not limited to rubber or plastic, such as poly-vinyl chloride (PVC) or linear low density polyethylene (LLDPE) or elastomers such as polyurethane or elastomeric polyamides or polyesters. Depending upon the material used, the first fastening member **10** and second fastening member **70** may be glued, heat welded or otherwise bonded to an adjacent material. In this regard, the fastening device may be formed as an integral part of an object during manufacture of the object itself. For example, the first and second fastening members may be attached to adjacent material surfaces as part of a product, such as, for example, a jacket front. Thus, the material surfaces would be the left and right front sides of the jacket, which substantially define a first plane. The interlocked first and second mating surfaces of the first and second members also substantially define a plane (which may be parallel), such as is illustrated in FIG. **4**. Additionally, the slider **90** is desirably made of a relatively hard material, such as, without limitation, a hard plastic, rubber, ceramic, metal, metal alloy, or a combination thereof. It is also contemplated that the slider may be made of a softer material.

[0041] Returning for FIGS. **1-3**, mating surfaces **30** and **80** may, if desired, incorporate a multitude of constructions and materials. For example, the mating surfaces may include rails **40** and channels **50** which facilitate the interlocking of the first fastening member with the second fastening member. In this regard, the rails and channels may form male and female shapes to aid in the interlocking of the fastening members. The rails and channels may be formed of one material, such as, for example, soft rubber. Alternatively, the rails and/or channels may be formed from a variety of materials including materials of higher durometer that still behaves in a resilient manner. To this end, the first fastening member **10** and second fastening member **70**, including mating surfaces **30** and **80** may incorporate metallic or hard plastic inserts. In addition, a variety of other materials, such as, without limitation, gel, silicone, polytetrafluoroethylene (PTFE) fibers, metal or coil zipper sections, lubricants, and/or sealants may all be used in or on one or more of the components of the fastening devices disclosed herein.

[0042] Referring to FIGS. **2** and **3**, in an embodiment of the invention, the rails and/or channels may be composed of one or more openings and/or projections. In this regard, for example, an opening can be present in the first fastening member or second fastening member and a projection can be present in the fastening member which does not contain the opening. Upon sealing of the fastening member, the projection, which may be of similar or same size, shape, and configuration as the opening, will be adapted to fit snugly inside the opening. Thus, upon insertion of an end **20** of the first and/or second fastening member into a stop block **100** of a garment (i.e. a jacket), the mating surface will be forced to be aligned properly (in order to form the seal). If the projection does not fit properly into the opening this indicates that the mating surfaces are not aligned properly. Thus, the projection and opening act as safeguard against improper operation of the waterproof fastening device. The stop block may be attached to an end of the fastening member by a variety of means including, but not limited to, applying adhesive. Alternatively, the absence of a stop block the ends may be welded or otherwise bonded together.

[0043] Additionally, in use, it is contemplated the two fastening members will be able to pass through the slider without obstruction and can be seated and unseated with the slider. However, because of the combination of the opening and projection, once seated, the two mating surfaces will be prevented from sliding past each other along the parallel axis of the fastening device.

[0044] It is also further contemplated that multiple openings and multiple projections may be used along the length of the mating surfaces of the first fastening member and second fastening member (See FIG. **3**). The use of multiple projections and openings may help to further ensure prevention of pullout of the fastening members. It is also contemplated that in some embodiments, the location of the projections and/or openings will be limited to the half of the mating surface that is closest to the stop block, while other embodiments may possess projections and/or openings along the entire length of the mating surfaces. It is also contemplated that in some embodiments of the invention a stop block may not be needed.

[0045] Regardless of the number of openings and projections, a variety of geometries may be used for the opening(s) and projections (s). Non-limiting examples include the shape of a circle, trapezoid, triangle, square, rhombus, rectangle, the like, or combinations thereof. Alternatively, the opening is a series of repeating geometries and/or repeating alternating geometries. It is also contemplated that the openings and projections may be in a notch/groove configuration and they may also relate to each other in planar or linear relation as well as non-planar and non-linear relations. It should also be noted that the projections and opening (as well as the additional configurations described below) may be oriented on the sides of the individual rails/and or channels as shown in FIG. **5**.

[0046] In one particular embodiment the projection/opening configuration may be created by providing two fastening members of similar shape, but not similar size. The fastening member having the oversized profile can be trimmed in the

longitudinal direction along the majority of the rail length leaving only a small section having the oversized profile. When the first and second extrusions are mated, this small oversized region presses tightly into a groove on the opposing rail thereby reducing the longitudinal slippage between the two rails. Optionally, a cavity, such as an indentation or slot or transverse groove or notch or the like, can be created in the mating rail of the second extrusion in a location so that the oversized section of the first extrusion fits into this cavity in the second extrusion. The presence of the oversized region of the first extrusion in the cavity of the second extrusion can also reduce the longitudinal slippage between the two extrusions.

[0047] In an additional embodiment of the invention interlocking protuberances **130** are used as locking mechanisms in lieu of the projection opening configuration. In practice at least one interlocking protuberance is in communication with the mating surface of the first fastening member. At least one corresponding interlocking protuberance is in communication with the mating surface of the second fastening member. Upon sealing of the fastening members together, the interlocking protuberances lock together, similar to a snap on a school backpack, to form a locking mechanism. The interlocking protuberances may be found on the surface of the rail, the channels of the rail, or combination thereof. Additionally, in some embodiments openings may be cut through the rails and/or channels of the first and/or second fastening members and the interlocking protuberances may be inserted therein. Further, the interlocking protuberances may be found in continuous and/or discontinuous patterns along the mating surfaces.

[0048] Regardless of how the interlocking protuberances are in communication with the mating surfaces, the protuberances may be formed from a wide variety of materials. These materials, include, but are not limited to plastic, metals, and other high durometer materials. The interlocking protuberances may also take on a variety of shapes and sized. Non-limiting examples of these are shown in FIGS. **6** and **7**.

[0049] A further embodiment of the invention utilizes high coefficient of friction mating surfaces for forming a locking mechanism. High coefficient of friction (COF) is a COF of greater than 0.7 utilizing standard COF testing as known in the art. These mating surfaces may be formed by many mechanisms including, but not limited to, sand blasting. Further, a high COF may be achieved by applying fine powder, abradents, silica, or the like to the mating surfaces in continuous or discontinuous patterns. In use, the high COF portions of the first fastening member mate with the high COF portions of the second fastening member to form a locking mechanism and help prevent pullout of the fastening device.

[0050] Turning to FIG. **8**, in an additional embodiment of the invention, depressions **140** and peaks **150** are used along the rails **40** of the mating surfaces **10** are used to form a locking mechanism. The depressions **140** and peaks **150** along the rails may be formed by a variety of mechanisms including, but not limited to, cutting depressions out of the rails and heat soldering depressions into the rails. In practice, upon sealing of the fastening members together, the depressions and peaks of the first fastening member interlock with the depressions and peaks of the second fastening member to form a locking mechanism that renders the fastening device resistant to pullout.

[0051] Desirably, the fastening devices of the present invention resist pull-out when between about 10 up to about 50 Newtons of Force, more desirably between about 10 up to about 90 units of force, more desirably between about 10 and about 200 Newton of force, and even more desirably between about 10 and about 400 Newtons of force is applied. It is also contemplated that the fastening devices of the present invention may resist pull-out when more than 400 Newtons of force is applied. In contrast, fastening devices which do not utilize the locking mechanisms described above may typically experience pullout when less than 10 Newtons of force is applied to the fastening members. A description of the method utilized to determine holding force is below.

[0052] The above described fastening devices of the present invention have a wide variety of uses and advantages. In general, the device can be used for outdoor clothing and apparel, outdoor equipment and cases, marine apparel and equipment, and even for everyday apparel. The device is particularly useful for products that are required to be fully waterproof. Such products include, without limitation, hazardous material suits, fire suits, dry suits, dry bags, bivy sacks, waders, space suits, tents, shipping packages, household storage bags, map cases, chart cases, kayak skirts, backpack covers, computer cases, electronic device cases, watercraft containers, inflatable cases (for cameras, etc.), flotation bags, flotation devices, waterproof pockets, fishing vest pockets, smell-proof pockets (for bears, etc.), and wetsuits. The device of the present invention is also particularly useful for products requiring or benefiting from being wind proof. Such products include, without limitation, jackets, sleeping bags, rain gear, boots, kayak jackets, wind breakers, wind proof fleeces, and tents. In addition to the advantages of being waterproof and wind proof, the device of the present invention has a number of other advantages, including, without limitation, being: airtight, watertight, gas tight, wind proof, quiet, less likely to get caught or jammed, lightweight, nonmetal (i.e., light, cheap and not cold), fully recyclable, smooth to operate, inexpensive and easy to produce. This device also eliminates the need for zipper-covering flaps and can be used in essentially any zipper function, thereby allowing hundreds of new products to be made using the device. Specifically, such new products can include the following: zip-down waders, zip-down dry bags, zip-down bivy sacks, easy access kayak skirts, fully waterproof rope bags, fully waterproof pockets, watertight/airtight shipping packages, easy access dry suits, everyday camera bags for underwater photos or films, fully waterproof and fully functional backpacks or fanny packs, zip-down rain pants and zip-in-half rain tarps.

Waterproofness

[0053] In order to test the waterproofness of the fastening devices described herein, the devices where subjected to the Suter test as known in the art, described below. Fastening devices (available from W.L. Gore and Associates, Elkton, Md.) were attached, by seam sealing as known in the art, to a waterproof laminate fabric (available from W.L. Gore and Associates, Elkton, Md.) appropriate for use in a waterproof jacket. The sample tested and described below included a portion of the fabric and the fastening device including the intersections (s) where the fabric was attached to the fastening device.

Suter Test for Water Entry Pressure

[0054] To determine whether a protective barrier fabric or the seams of a garment made from the protective barrier fabric

are waterproof, the Suter test procedure is used, which is based generally on the description in ISO 811-1981. This procedure provides a low pressure challenge to the sample being tested by forcing water against one side of the test sample and observing the other side for indication that water has penetrated through the sample.

[0055] The sealed seam test sample is clamped and sealed between rubber gaskets in a fixture that holds the sample so that water can be applied to an area of the sample 3 inches in diameter (7.62 cm). The water is applied under air pressure of 3 psig (0.21 bar) to one side of the sample. In testing a fabric laminate, the water would be applied to the face or exterior side. In testing a sealed seam, water is applied to the face side of the sample and the opposite side, or seam backer layer, is observed for leaks.

[0056] The opposite side of the sample is observed visually for any sign of water appearing (either by wicking or the appearance of droplets) at the seam edge for 3 minutes. If no water is observed, the sample has passed the test and the sample is considered to have a water entry pressure greater than the 3 psig load at which the test was conducted. In the case of the fastening devices of the present invention, all samples passed the Suter test and are considered waterproof.

Holding Force Test

[0057] Samples in accordance with the present invention were tested to measure their resistance to pull-out as described previously herein. An illustration of the test is in FIG. **10** and a description of the test follows.

Procedure:

[0058] 1 Seat the two fastening members by hand, making sure the locking mechanism is securely closed. In the case of fastening members with projection(s) and opening(s), the locking mechanisms are the rails and channels of the mating surfaces as well as the placement of the projection into the opening to securely seal the mating surface of the first fastening member to the second fastening member. In some examples, the projection was constructed from the rubber materials utilized for construction of the mating surfaces. In other examples, the projection was constructed from a set or sets of metal inserts attached to a mating surface. In yet other examples, peaks and depressions as described above were utilized in lieu of openings and/or projections.

2. Attach a vice grip to one end of one of the fastening members.

3. Attach a force gauge to the other fastening member on the end opposite to where the vice grip is attached.

4. Pull the vice grip and the force gauge apart from one another until the fastening members slide apart and disengage.

5. Record the maximum force required to cause the fastening members to slide apart and disengage.

Example 1

[0059] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 6 mm in width and having projections and openings was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa. From the first fastening member, a section of the center rail of approximately 9 mm was removed to form an opening. This section of rail was then shortened to 7 mm and inserted into the corresponding channel of the second fastening member to form a projection and was thereafter adhered using Super Glue brand adhesive from The Original Super Glue Corporation, Rancho Cucamonga, Calif. The placement of the glued in insert was such that when the two fastening members were assembled, the insert in the second fastening member would align with the removed section of rail in the first fastening member. Two additional sections of rail were then removed from the first fastening member at 9 mm intervals, trimmed, then inserted and adhered into the corresponding sections of the second fastening member in the same manner as before. In this manner a locking mechanism consisting of three openings and three projections was constructed. The resulting fastening device exhibited a holding force of 42.7N when subjected to the holding force test. Additionally air permeability was measured utilizing the FX3300-II (test pressure 100 PA) available from Advanced Testing Instruments, Inc., Greer, S.C. Air permeability was at 0.06 $L/m^2/s$.

Example 2

[0060] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 6 mm in width and having projections and openings was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa. An opening 13 mm long and approximately 0.5 mm wider than the center rail was cut completely through both fastening members, thereby removing a portion of the center rail and the underlying material. A plastic insert consisting of one angled protrusion, made using a castable urethane, PT8902 material from PTM&W Industries Inc., Santa Fe Springs, Calif. was then inserted into the opening of the first fastening member, as shown in FIGS. **6** and **7**. A second identical plastic insert was then inserted into the opening of the second fastening similarly to the first insert, but with the one angled protrusion oriented in the opposite direction in such a way that when the two fastening members were assembled, the two plastic inserts would fit together snugly. These plastic inserts were adhered to the fastening members using Super Glue brand adhesive from The Original Super Glue Corporation, Rancho Cucamonga, Calif. The placement of the glued in insert was such that when the two fastening members were assembled, the insert in the second fastening member would align with the insert in the first fastening member. In this manner a locking mechanism having two interlocking plastic inserts was constructed. The resulting fastening device exhibited a holding force of 54.9 N when subjected to the holding force test.

Example 3

[0061] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 6 mm in width and having projections and openings was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members

were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa. From the first fastening member, a section of the center rail of approximately 9 mm was removed to form an opening. This section of rail was then shortened to 7 mm and inserted into the corresponding channel of the second fastening member to form a projection and was thereafter adhered using Super Glue brand adhesive from The Original Super Glue Corporation, Rancho Cucamonga, Calif. The placement of the glued in insert was such that when the two fastening members were assembled, the insert in the second fastening member would align with the removed section of rail in the first fastening member. One additional section of rail was then removed from the first fastening member at 9 mm intervals, trimmed, then inserted and adhered into the corresponding sections of the second fastening member in the same manner as before. In this manner a locking mechanism having two openings and two projections was constructed. The resulting fastening device exhibited a holding force of 29N when subjected to the holding force test.

Example 4

[0062] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 6 mm in width and having projections and openings was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa. From the first fastening member, a section of the center rail of approximately 9 mm was removed to form an opening. This section of rail was then shortened to 7 mm and inserted into the corresponding channel of the second fastening member to form a projection and was thereafter adhered using Super Glue brand adhesive from The Original Super Glue Corporation, Rancho Cucamonga, Calif. The placement of the glued in insert was such that when the two fastening members were assembled, the insert in the second fastening member would align with the removed section of rail in the first fastening member. In this manner a locking mechanism consisting of one opening and one projection was constructed. The resulting fastening device exhibited a holding force of 15.4N when subjected to the holding force test.

Example 5

[0063] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 6 mm in width and having projections and openings was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa. The resulting fastening device exhibited a holding force of less than 10 N when subjected to the holding force test.

Example 6

[0064] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 6 mm in width and having projections and openings was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa. An opening 13 mm long and approximately 0.5 mm wider than the center rail was cut completely through both fastening members, thereby removing a portion of the center rail and the underlying material. A plastic insert consisting of two angled protrusions, made using a castable urethane, PT8902 material from PTM&W Industries Inc., Santa Fe Springs, Calif. was then inserted into the opening of the first fastening member, as shown in FIGS. **6** and **7**. A second identical plastic insert was then inserted into the opening of the second fastening similarly to the first insert, but with the two angled protrusions oriented in the opposite direction in such a way that when the two fastening members were assembled, the two plastic inserts would fit together snugly. These plastic inserts were adhered to the fastening members using Super Glue brand adhesive from The Original Super Glue Corporation, Rancho Cucamonga, Calif. The placement of the glued in insert was such that when the two fastening members were assembled, the insert in the second fastening member would align with the insert in the first fastening member. An additional opening (approximately 9 mm from the first opening) 13 mm long and approximately 0.5 mm wider than the center rail was created in the same manner described above and plastic inserts were placed therein. In this manner a locking mechanism having two interlocking plastic inserts was constructed. The resulting fastening device exhibited a holding force of 89.1 N when subjected to the holding force test.

Example 7

[0065] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 6 mm in width and having depressions perpendicular to the longitudinal axis was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa.

[0066] A thin metal ruler was placed inside the channel of the first fastening member. Then a heated soldering iron with a tip of diameter approximately 0.7 mm was inserted between the metal ruler and the adjacent rail thereby melting the side of the rail and forming a depression on the side of the rail adjacent to the channel. This process of forming a depression was repeated down the entire length of the first fastening member at intervals of approximately 1.58 mm, thus forming a row of depressions with corresponding raised areas (peaks) in between. Depressions were then created down the entire length of the second fastening member in an identical manner. The depressions and peaks were located on the sides of the rails in such a manner that when the first fastening member and second fastening member were seated together, the depressions and peaks on the first fastening member lined up and interacted with the depressions and peaks on the second fastening member.

[0067] In this manner a locking mechanism having two rows of interacting depressions and peaks was created. The

resulting fastening device exhibited a holding force of 59.1N when subjected to the holding force test.

Example 8

[0068] A first and second fastening member similar in shape to FIG. **2**, having mating surfaces 9 mm in width and having depressions perpendicular to the longitudinal axis was manufactured using a Davis Standard 2-inch single screw extruder with a 24:1 Length/Diameter ratio, available from Davis-Standard, LLC, Pawcatuck, Conn. The first and second fastening members were constructed from a thermoplastic polyurethane Texin 990R of approximately 90 Shore A hardness available from Bayer Corporation Pittsburgh, Pa.

[0069] A thin metal ruler was placed inside the channel of the first fastening member. Then a heated soldering iron with a tip of diameter approximately 0.7 mm was inserted between the metal ruler and the adjacent rail thereby melting the side of the rail and forming a depression on the side of the rail adjacent to the channel. This process of forming a depression was repeated down the entire length of the first fastening member at intervals of approximately 1.58 mm, thus forming a row of depressions with corresponding raised areas (peaks) in between. Depressions were then created down the entire length of the second fastening member in an identical manner. The depressions were located on the sides of the rails in such a manner that when the first fastening member and second fastening member were seated together, the depressions and peaks on the first fastening member lined up and interacted with the depressions and peaks on the second fastening member.

[0070] In this manner a locking mechanism having two rows of interacting depressions and peaks was created. The resulting fastening device exhibited a holding force of 101.3N when subjected to the holding force test.

[0071] It is contemplated that fastening devices constructed of mating surfaces having higher durometer materials and/or having wider mating surfaces (See FIG. **9**) could have max holding forces of up to 400 N or greater.

[0072] By way of non-limiting example, with regard to the fastening devices constructed with inserts, if instead of using cast polyurethane for the insert materials, steel, for example, was used, it is contemplated that holding forces as high as high as 400 N and beyond could be achieved. For example, an insert constructed of steel with an ultimate tensile strength of 58,000 psi and a tensile modulus of 30,000,000 psi, would have a holding force at least five times as great as an insert constructed with PT8902, which has a tensile strength of 10,010 psi and a tensile modulus of 371,000 psi.

[0073] The resulting data from the Holding Force Test are summarized below.

Mating Surface	Locking Mechanism	# of projections	Max Holding Force (N)
6 MM	None	0	<10
6 MM	90A Durometer TPU	1	15.4
6 MM	90A Durometer TPU	2	29
6 MM	90A Durometer TPU	3	42.7
6 MM	PT89-02 from PTM & W - 1 set of inserts	1	54.9
6 MM	PT89-02 from PTM & W - 2 sets of inserts	2	89.1
6 MM	90A Durometer TPU - Peaks and Depressions	NA	59.1
9 MM	90A Durometer TPU - Peaks and Depressions	NA	101.3

1. A fastening device comprising

A first fastening member comprising two opposing ends and further comprising a first mating surface comprising a plurality of rails having channels there between, wherein at least one of said plurality of rails comprises an opening;

A second fastening member comprising two opposing ends and further comprising a second mating surface comprising a plurality of rails having channels there between, wherein said second mating surface is adapted for operatively engaging said first mating surface, further wherein at least one of said channels comprises a projection which is adapted to engage said opening when said first mating surface and said second mating surfaces are operatively engaged;

2. The device of claim **1**, wherein the fastening device is waterproof.

3. The device of claim **1**, further comprising a slider, said slider being engageable with said first and second mating surfaces and being adapted for forming and maintaining a waterproof seal between said first and said second mating surfaces, said sliders further being movable along said first and said second mating surfaces.

4. The device of claim **1**, further comprising a stop block fixedly connected to one end of said two opposing ends of said first fastening member or said second fastening member, said stop block being adapted to house said one end of said first fastening member and said second fastening member when said first mating surface and said second mating surface are operatively engaged.

5. The device of claim **1**, wherein said opening and said projection are positioned closer to said end comprising a stop block fixedly connected thereto than to said opposing end.

6. The device of claim **1**, wherein said opening comprises the shape of a circle, trapezoid, triangle, square, rhombus, rectangle, or the like and said projection adapted to engage said opening comprises the same shape.

7. The device of claim **1**, wherein said opening comprises a series of repeating alternating geometries and said projection adapted to engage said opening comprises the same shape.

8. The device of claim **1**, wherein said opening comprises a series of repeating geometries and said projection adapted to engage said opening comprises the same shape.

9. A product comprising the device, as claimed in claim **1**, wherein said product is a hazardous material suit, fire suit, dry suit, dry bag, body bag, wader, bivy suit, space suit, waterproof pocket, fishing vest pocket, smell-proof pocket, wetsuit, jacket, rain gear, boot, shoe, kayak jacket, wind breaker, wind proof fleece, or the like.

11. The device of claim **1** wherein the first fastening member and second fastening members do not pull-out when between about 10 up to about 50 Newtons of force is applied using the holding force test.

12. The device of claim **1**, wherein the first mating surface and second mating surface is comprised of polyurethane.

13. The device of claim **1**, wherein the first mating surface and second mating surface is comprised of rubber, polyamide, polyester, PVC, or styrenic block co-polymers.

14. The device of claim **1**, wherein the projection is comprised of polyamide, polyester, polyvinyl chloride, rubber, polyethylene, polypropylene, polyurethane, polycarbonate, polystyrene, high impact polystyrene, polyethylene terephthalate, polymethyl methacrylate, polyetheretherketone, polyoxymethylene, or polyetherimide.

15. The device of claim **1**, wherein the projection is comprised of a metallic material.

16. A first fastening member comprising two opposing ends and further comprising a first mating surface comprising a plurality of rails having channels there between, wherein at least one of said plurality of rails comprises multiple openings;

A second fastening member comprising two opposing ends and further comprising a second mating surface comprising a plurality of rails having channels there between, wherein said second mating surface is adapted for operatively engaging said first mating surface, further wherein at least one of said channels comprises multiple projections which are adapted to engage said multiple openings when said first mating surface and said second mating surfaces are operatively engaged;

17. The device of claim **16**, wherein the device is waterproof.

18. The device of claim **16**, further comprising a slider, said slider being engageable with said first and second mating surfaces and being adapted for forming and maintaining a waterproof seal between said first and said second mating surfaces, said sliders further being movable along said first and said second mating surfaces.

19. The device of claim **16**, a stop block fixedly connected to one end of said two opposing ends of said first fastening member or said second fastening member, said stop block being adapted to house said one end of said first fastening member and said second fastening member when said first mating surface and said second mating surface are operatively engaged.

20. The device of claim **16**, wherein said multiple openings comprise the shape of a circle, trapezoid, triangle, square, rhombus, rectangle, combinations thereof or the like and said multiple projections adapted to engage said multiple openings comprises the same shape.

21. The device of claim **16**, wherein said multiple openings comprises a series of repeating alternating geometries and said multiple projections adapted to engage said multiple openings comprise the same shape.

22. The device of claim **16**, wherein said multiple openings comprise a series of repeating geometries and said multiple projections adapted to engage said multiple openings comprises the same shape.

23. A product comprising the device, as claimed in claim **16**, wherein said product is a hazardous material suit, fire suit, dry suit, dry bag, body bag, wader, bivy suit, space suit, waterproof pocket, fishing vest pocket, smell-proof pocket, wetsuit, jacket, rain gear, boot, shoe, kayak jacket, wind breaker, wind proof fleece, or the like.

24. The device of claim **16** wherein the first fastening member and second fastening members do not pull-out when between about 10 up to about 50 Newtons of force is applied using the holding force test.

25. The device of claim **16**. wherein the first fastening member and second fastening members do not pull-out when between about 10 up to about 90 Newtons of force is applied using the holding force test.

26. A fastening device comprising:

A first fastening member comprising two opposing ends and further comprising a first mating surface comprising a plurality of rails having channels there between

A second fastening member comprising two opposing ends and further comprising a second mating surface comprising a plurality of rails having channels there between, wherein said second mating surface is adapted for operatively engaging said first mating surface

At least one interlocking protuberance positioned in communication with the mating surface of the first fastening member and at least one interlocking protuberance in communication with the mating surface of the second fastening member wherein the at least one interlocking protuberance positioned in communication with the mating surface of the first fastening member and the at least one interlocking protuberance in communication with the mating surface of the second fastening member are adapted to interlock with each other when said first mating surface and said second mating surface are operatively engaged.

27. The device of claim **26**, wherein the device is waterproof

28. The device of claim **26**, further comprising a slider, said slider being engageable with said first and second mating surfaces and being adapted for forming and maintaining a seal between said first and said second mating surfaces, said sliders further being movable along said first and said second mating surfaces.

29. The device of claim **26**, further comprising a stop block fixedly connected to one end of said two opposing ends of said first fastening member or said second fastening member, said stop block being adapted to house said one end of said first fastening member and said second fastening member when said first mating surface and said second mating surface are operatively engaged.

30. A fastening device comprising:

A first fastening member comprising two opposing ends and further comprising a first mating surface comprising a plurality of rails having channels there between a second fastening member comprising two opposing ends and further comprising

a second mating surface comprising a plurality of rails having channels there between, wherein said second mating surface is adapted for operatively engaging said first mating surface,

wherein the first fastening member and second fastening member do not pull-out when between about 10 up to about 400 Newtons of force is applied using the holding force test.

31. The device of claim **30**, wherein the first fastening member and second fastening member do not pull-out or slide past each other when between about 10 up to about 90 Newtons of force is applied using the holding force test.

32. The device of claim **30**, wherein the first fastening member and second fastening member do not pull-out or slide past each other when between about 10 up to about 200 Newtons of force is applied using the holding force test.

33. The device of claim **30**, wherein the device is waterproof.

34. The device of claim **30**, further comprising a slider, said slider being engageable with said first and second mating surfaces and being adapted for forming and maintaining a seal between said first and said second mating surfaces, said sliders further being movable along said first and said second mating surfaces.

35. The device of claim **30**, further comprising a stop block fixedly connected to one end of said two opposing ends of said first fastening member or said second fastening member, said stop block being adapted to house said one end of said first fastening member and said second fastening member when said first mating surface and said second mating surface are operatively engaged.

36. A fastening device comprising:

A first fastening member comprising two opposing ends and further comprising a high coefficient of friction first mating surface comprising a plurality of rails having channels there between.

a second fastening member comprising two opposing ends and further comprising a high coefficient of friction second mating surface comprising a plurality of rails having channels there between, wherein said second mating surface is adapted for operatively engaging said first mating surface

37. The device of claim **36**, wherein the device is waterproof.

38. The device of claim **36**, further comprising a slider, said slider being engageable with said first and said second mating surfaces and being adapted for forming and maintaining a seal between said first and said second mating surfaces, said sliders further being movable along said first and said second mating surfaces.

39. The device of claim **36**, further comprising a stop block fixedly connected to one end of said two opposing ends of said first fastening member or said second fastening member, said stop block being adapted to house said one end of said first fastening member and said second fastening member when said first mating surface and said second mating surface are operatively engaged.

40. A fastening device comprising

A first fastening member comprising two opposing ends and further comprising a first mating surface comprising a plurality of rails, each of said plurality of rails having a length, wherein at least one of said plurality of rails comprises a plurality of depressions and peaks thereon;

A second fastening member comprising two opposing ends and further comprising a second mating surface comprising a plurality of rails, each of said plurality of rails having a length, wherein at least one of said plurality of rails comprises a plurality of depressions and peaks thereon, wherein said second mating surface is adapted for operatively engaging said first mating surface, and further wherein the first fastening member and the second fastening member oppose pullout when the plurality of depressions and peaks of the first fastening member interlock with the plurality of depressions and peaks of the second fastening member

41. The device of claim **40**, wherein the fastening device is waterproof

42. The device of claim **40**, further comprising a slider, said slider being engageable with said first and second mating surfaces and being adapted for forming and maintaining a waterproof seal between said first and said second mating surfaces, said slider further being movable along said first and said second mating surfaces.

43. The device of claim **40**, further comprising a stop block fixedly connected to one end of said two opposing ends of said first fastening member or said second fastening member, said stop block being adapted to house said one end of said first fastening member and said second fastening member when said first mating surface and said second mating surface are operatively engaged.

44. The device of claim **40** wherein the plurality of peaks and depressions of the first fastening member are formed in a discontinuous pattern.

45. The device of claim **40** wherein the plurality of peaks and depressions of the first fastening member are formed in a continuous pattern.

46. The device of claim **40** wherein the plurality of peaks and depressions of the second fastening member are formed in a discontinuous pattern.

47. The device of claim **40** wherein the plurality of peaks and depressions of the second fastening member are formed in a continuous pattern.

48. The device of claim **40** wherein the plurality of peaks and depressions are formed along the entire length of that least one of said plurality of rails of the first fastening device and the second fastening device.

49. The device of claim **40** wherein the plurality of peaks and depressions are formed along a portion of the length of that least one of said plurality of rails of the first fastening device and the second fastening device.

50. A product comprising the device, as claimed in claim **40**, wherein said product is a hazardous material suit, fire suit, dry suit, dry bag, body bag, wader, bivy suit, space suit, waterproof pocket, fishing vest pocket, smell-proof pocket, wetsuit, jacket, rain gear, boot, shoe, kayak jacket, wind breaker, wind proof fleece, or the like.

51. The device of claim **1** wherein the first fastening member and second fastening members do not pull-out when between about 10 up to about 200 Newtons of force is applied using the holding force test.

52. The device of claim **16** wherein the first fastening member and second fastening members do not pull-out when between about 10 up to about 200 Newtons of force is applied using the holding force test.

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