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FASTENER RETENTION METHOD AND APPARATUS

Abstract

A fastener retention apparatus with a body having a cavity to receive a fastener. The body having a ring disposed thereon, wherein the ring is configured for rotation on the body such that at least one locking ball transitions between an engagement position and a disengagement position within an orifice on the body for selective rotation of the fastener. A method of retaining a fastener.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application claims priority to U.S. Provisional Patent Application No. 63/554,163 filed on Feb. 16, 2024, titled “Fastener Retention Method and Apparatus.” The entire disclosure of Application No. 63/554,163 is hereby incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This disclosure relates generally to devices for securing fasteners. More particularly, the disclosure relates to a retention device that is capable of securing a fastener on the shank of a pin member for an indefinite period of time.

BACKGROUND

[0003] Mechanical bolts are generally held in place by different types of conventional fasteners (e.g., cotter pins, keys, wires, threaded nuts, etc.). For many applications, the use of conventional fasteners is sufficient. However, some applications require a more secure means of ensuring the fastener will stay put and not become dislodged from the bolt. For example, shackles are devices that are used as connecting links in all manner of rigging systems in many industries, from boats and ships to industrial crane rigging, as they allow different bolt rigging subsets to be connected or disconnected quickly. Some shackles are used in temporary rigging to make lifts while other applications require shackles to remain in service for an extended period. Conventional shackles used for suspending objects require that the nut or fastener remain securely in place for safety reasons as well as operability.

[0004] FIG. **1** shows a conventional shackle **10** complete with a threaded pin member **12**, customary half-width securing hex nut fastener **14**, and a hole **16** for a retaining pin complete with a cotter pin **18** installed. In this type of installation, the shackle **10** is typically secured to slings or other equipment or lifting members, the pin member **12** is installed through each hole in the shackle leg, the nut **14** is screwed onto the pin threads and adequately tightened, and the cotter pin **18** is installed through the hole **16** in the end of the pin. Such shackles **10** are designed and manufactured to safely handle loads from tens of pounds to thousands of tons.

[0005] A common issue with shackles and other types of fasteners is the failure of the bolt or pin member to remain securely fastened in place. The sudden failure of fasteners can cause work delays, equipment damage, or worse, human injury or death. This is a particular issue when fasteners are used for extended duration or in high-energy environments where continual motion, loading cycles, or vibration occur, increasing the likelihood of loosening and unexpected pin member separation. For bolt-type pin members, the nut or fastener may not be properly torqued. For round pin or bolt-type pin members that use a cotter key or other retaining clip or wire, the retaining mechanism may be improperly sized (pin too small), improper for the application (diaper pin vs. cotter pin), or the retention component may be reused resulting in a weakened retention system (reused cotter pins). Incorrect material type is also a potential cause of fastener failure. Primary or secondary fastener components (keys, wires, cotter pins, etc.) with substandard material characteristics (hardness, ductility, alloy composition) are susceptible to fatigue, breakage and corrosion.

[0006] A need remains for a device that can be used on a variety of pin members that will positively secure a fastener to the member, preventing unintended release of the pin or fastener, and be easily installed or removed without the need for special tools.

SUMMARY

[0007] According to an aspect of the invention, a fastener retention apparatus includes a body having a cavity to receive a fastener. The body having a ring disposed thereon, wherein the ring is configured for rotation on the body such that at least one locking ball transitions between an engagement position and a disengagement position within an orifice on the body for selective rotation of the fastener.

[0008] According to another aspect of the invention, a method of retaining a fastener includes

disposing a fastener on a body having a cavity to receive the fastener, and selectively rotating the fastener by rotating a ring disposed on the body such that at least one locking ball transitions between an engagement position and a disengagement position within an orifice on the body.
[0009] Other aspects of the embodiments described herein will become apparent from the following description and the accompanying drawings, illustrating the principles of the embodiments by way of example only.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0010] The following figures form part of the present specification and are included to further demonstrate certain aspects of the present disclosure and should not be used to limit or define the claimed subject matter. The claimed subject matter may be better understood by reference to one or more of these drawings in combination with the description of embodiments presented herein. Consequently, a more complete understanding of the present embodiments and further features and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings, in which like reference numerals may identify like elements, wherein:
[0011] FIG. **1** shows a perspective view of a conventional shackle with a customary locking fastener and securing pin.
[0012] FIG. **2** shows a perspective view of a fastener retention body according to an example of the present disclosure.
[0013] FIG. **3** shows a side view of the fastener retention body of FIG. **2**.
[0014] FIG. **4** shows a perspective view of a ring section according to an example of the present disclosure.
[0015] FIG. **5**A shows a plan view of a ring section according to an example of the present disclosure.
[0016] FIG. **5**B shows a plan view of another ring section according to an example of the present disclosure.
[0017] FIG. **6** shows a perspective view of a fastener retaining body and ring assembly according to an example of the present disclosure.
[0018] FIG. **7** shows a plan view cross section of a fastener retaining body and ring assembly according to an example of the present disclosure.
[0019] FIG. **8** shows another plan view cross section of the fastener retaining body and ring assembly of FIG. **7**.
[0020] FIG. **9** shows a perspective view of a conventional shackle with a fastener retaining body and ring assembly according to an example of the present disclosure.
DETAILED DESCRIPTION
[0021] The foregoing description of the figures is provided for the convenience of the reader. It should be understood, however, that the embodiments are not limited to the precise arrangements and configurations shown in the figures. Also, the figures are not necessarily drawn to scale, and certain features may be shown exaggerated in scale or in generalized or schematic form, in the interest of clarity and conciseness. It will be understood that as used in this description, the term “pin member” encompasses all forms of screws, bolts, locking pins, and other forms of devices having a shank and used to fasten and/or retain items as known in the art. It will also be understood that as used in this description, the term “fastener” encompasses all forms of nut types used to couple to pin members as known in the art.
[0022] FIG. **2** shows a perspective view of a fastener retention body **20** embodiment of this disclosure. In some embodiments, the body **20** is formed as a one-piece circular structure. A cavity

22 is formed to define one side of the body **20**. The illustrated body **20** embodiment shows the cavity **22** formed with sufficient depth and linear walls **24** defining a space to receive and rigidly hold a conventional hex nut fastener (see **70** in FIG. **9**). It will be understood by those skilled in the art that other body **20** embodiments may be configured with the cavity **22** formed to receive and hold other types of fasteners (e.g. square nuts). The cavity **22** opening has a smooth planar surface **26**. In some embodiments, the body **20** may be configured with one or more protrusions **28** extending outward from the exterior side wall of body near the cavity **22** opening. The protrusion(s) **28** facilitates manipulation and rotation of the body **20** by a user (further described below). The body **20** is also formed with an opening **30** along its central axis. The opening **30** is configured to allow a pin member to pass through a fastener retained in the cavity **22** (see FIGS. **7**, **8**, **9**).

[0023] Turning to FIG. **3**, a side view of a body **20** embodiment is shown. The body **20** is configured with a raised section **32** extending from the surface **34** opposite the cavity **22**. The raised section **32** forms a column with a smaller radius compared to the radius of the walled section defining the cavity **22**. The top of the raised section **32** terminates to form a flat annular disc **36** (see FIG. **6**). The disc **36** section is formed with a greater diameter compared to the diameter of the raised section **32**. In some embodiments, the disc **36** section is formed with a diameter to match the diameter of the cavity **22** section (see FIG. **6**). In between the disc **36** and surface **34**, an annular gap **38** is formed. The raised section **32** is also configured with an orifice **40** laterally extending through the wall of the column. The body **20** is also configured with a detent **42**, in the form of a pin, extending between surface **34** and the inner surface of disc **36** (further described below).

[0024] FIG. **4** shows a perspective view of a section **44**A forming one-half of a ring (see **60** in FIG. **6**). The section **44**A is formed as an arch structure with a smooth curved exterior surface **46**A. The embodiment shown in FIG. **4** is configured with a raised protrusion **48** extending outward from a section of the exterior surface **46**A. The protrusion **48** facilitates manipulation and rotation of the ring **60** by a user (further described below). One end of the arch section **44**A is formed with a contoured extension **50**A having a recess and/or ridge formation. The other end of the arch section **44**A is also formed with a contoured extension **52**A having a recess and/or ridge formation. The inner surface of the arch section **44**A is configured with one or more semi-circular indentations or voids **54**A. A channel **56** is formed along the curved section of the arch section **44**A. The channel **56** forms a walled curved section with an opening on one side of the section **44**A. A slit **58** is formed along the inner wall of the arch section **44**A near the center of the channel **56**.

[0025] FIG. **5**A shows a plan view of the ring section **44**A of FIG. **4**. This view more clearly shows the geometry of the contoured extensions **50**A, **52**A. FIG. **5**B shows a plan view of another section **44**B forming one-half of a ring (see **60** in FIG. **6**). The section **44**B is also formed as an arch structure with a smooth curved exterior surface **46**B. The embodiment shown in FIG. **5**B is also configured with a raised protrusion **48** extending outward from a section of the exterior surface **46**B. The inner surface of the arch section **44**B is also configured with one or more semi-circular indentations or voids **54**B. One end of the arch section **44**B is formed with a contoured extension **50**B having a recess and/or ridge formation configured to match and couple with the contoured extension **50**A of section **44**A. The other end of the arch section **44**B is also formed with a contoured extension **52**B having a recess and/or ridge formation configured to match and couple with the contoured extension **52**A of section **44**A. As can be seen in FIGS. **5**A and **5**B, when the two sections **44**A, **44**B are joined together such that the contoured extensions **50**A, **50**B, **52**A, **52**B respectively engage one another, a ring is formed (see **60** in FIG. **6**).

[0026] FIG. **6** shows a perspective view of a retainer body **20** configured with a ring **60** embodiment of this disclosure. The ring **60** is formed by disposing the two sections **44**A, **44**B in the annular gap **38** of the body **20** around the raised section **32** (see FIG. **3**). The two sections **44**A, **44**B are joined together such that the contoured extensions **50**A, **50**B, **52**A, **52**B respectively engage one another to form the ring **60**. As shown in FIG. **6**, embodiments can be implemented

with the body **20** and the ring **60** each respectively having a pair of protrusions **28**, **48** formed on the exterior surfaces such that the protrusions are in alignment with one another when the ring **60** is disposed on the body **20**.

[0027] FIG. **7** shows a plan view cross section of a body **20** configured with a ring **60** embodiment of this disclosure. Although embodiments may be implemented with a ring **60** having only one arch section **44**A with a curved channel **56** (see FIG. **5**A), the embodiment of FIG. **7** is configured with each arch section **44**A, **44**B having a respective channel **56**A, **56**B formed therein. In this embodiment, the two sections **44**A, **44**B mirror each other in terms of components and functionality. Each section **44**A, **44**B respectively includes a pair of springs **62**A, **62**B disposed in each channel **56**A, **56**B. Any conventional spring **62**A, **62**B means may be used to implement embodiments of this disclosure. Each set of springs **62**A, **62**B is separated from one another by a pair of detents **42** disposed on the body **20** surface **34** (see FIG. **3**). When joining the arch sections **44**A, **44**B to dispose the ring **60** on the body, the slit **58** (see FIG. **4**) formed along the inner wall of each section permits the respective detent **42** to pass through so that the sections can be slid into place in the annular gap **38**. FIG. **7** shows the contoured extensions **50**A, **50**B, **52**A, **52**B respectively coupled with one another to form the ring **60**. FIG. **7** also shows the cross section of a pin member **64** disposed to pass through the central opening **30** formed on the body **20** (see FIG. **9**). The pin member **64** is configured with a pair of indentations or voids **66** to receive and seat a pair of locking balls **68** disposed in the orifices **40** in the raised section **32** of the body **20**.

[0028] FIG. **7** shows an embodiment wherein the locking balls **68** are in the engagement position within the orifices **40** in the raised section **32** of the body **20**. In this position, the balls **68** are recessed in the orifices **40** such that they seat within the voids **66** in the pin member **64**. With the balls **68** seated within the voids **66**, the pin member **64** is physically locked with the raised section **32** of the body **20**. The body **20**, in turn, holds and retains the fastener (see **70** in FIG. **9**). Thus, the fastener **70** is restrained from rotation with respect to the pin member **64**. In this manner, the fastener **70** is securely locked in place on the pin member **64**. With bolt-type pin members **64** the fastener **70** may consist of a threaded nut to engage with the threads on the shank of the bolt.

[0029] Turning to FIG. **8**, operation of the embodiment of FIG. **7** to transition from the engagement position to a disengagement position is now described. By turning the ring **60** to the right (as shown by the arrow) with respect to the body **20**, the voids **54**A, **54**B in the ring (see FIGS. **4**, **5**A, **5**B) are brought into alignment with the orifices **40** on the body **20**. Once in alignment, the voids **54**A, **54**B on the ring provide sufficient room for the locking balls **68** to ride out of the voids **66** on the pin member **64** to reside seated against the ring voids **54**A, **54**B. With the balls **68** seated within the ring **60** voids **54**A, **54**B, the body **20** is now physically locked with the ring **60**, while the pin member **64** is unlocked from the body **20**. In this position, the fastener **70** in the body **20** cavity **22** is free to rotate with respect to the pin member **64**, and vice-versa. For standard right-handed threaded pin members **64**, turning the ring **60** to the right as depicted by the arrow would tighten a threaded fastener **70** onto a threaded pin member coming out of the page as shown in FIG. **8**. Embodiments respectively configured with body **20** and ring **60** protrusions **28**, **48** facilitate manual rotation of the body and/or ring by a user.

[0030] FIG. **8** also shows the interaction of the springs **62**A, **62**B in the ring sections **44**A, **44**B during transition from the engagement position to the disengagement position. As the ring **60** is turned to the right as reflected by the arrow, springs **62**A are compressed against the respective detent **42** in each ring section **44**A, **44**B, while springs **62**B are in a neutral mode (i.e. uncompressed). In the compressed state, springs **62**A provide a biasing force (depicted by small arrows in FIG. **8**) against the rotation of the ring **60**, to the right in this case. As discussed above, a user would typically turn the ring **60** to the right to tighten a right-handed threaded fastener **70** on a pin member **64**.

[0031] Upon release of the turning force on the ring **60**, the force of the compressed springs **62**A against the respective detent **42** and channel **56**A, **56**B wall will automatically return the ring **60** to

the left. Upon return of the ring **60** to the left, the locking balls **68** rotate back into the orifices **40** in the raised section **32** of the body **20**, returning to the engagement position as shown in FIG. **7**. In this manner, the default state of the fastener **70** is to always remains securely retained from rotation with respect to the pin member **64** until the ring **60** is selectively rotated as desired.

[0032] It will be understood that rotation of the ring **60** in the opposite direction to that depicted in FIG. **8** (i.e., rotation toward the left of the image) will place springs **62**B in compression against the respective detent **42** in each ring section **44**A, **44**B, while springs **62**A will remain in a neutral mode (i.e. uncompressed). In this case, the compressed springs **62**B will provide a biasing force against rotation of the ring **60**, to the left in such case. As discussed above, a user would typically turn the ring **60** to the left to loosen a right-handed threaded fastener **70** on a pin member **64**. Transition between the engagement position and disengagement position will be the same as previously described in this case as well. Upon release of the turning force on the ring **60**, the force of the compressed springs **62**B against the respective detent **42** and channel **56**A, **56**B wall will automatically return the ring **60** to the right. Upon return of the ring **60** to the right, the locking balls **68** rotate back into the orifices **40** in the raised section **32** of the body **20**, returning to the engagement position as shown in FIG. **7**. In this manner, the fastener **70** always remains securely retained from rotation with respect to the pin member **64** until the ring **60** is selectively rotated as desired.

[0033] FIG. **9** shows the shackle **10** of FIG. **1** with a pin member **64** and fastener **70** secured in place by a retaining body **20** according to the embodiments of this disclosure. The pin member **64** may be a conventional metallic threaded bolt and the fastener **70** a conventional metallic threaded nut. As shown in FIG. **9**, the fastener **70** has been threaded into a locking position on the bolt **64** shaft by rotating the ring **60** and body **20** as described herein. Upon engagement of the fastener **70** to the pin member **64** to the desired tightness or torque, the ring **60** is positioned such that the locking balls **68** are in the engagement position and the fastener **70** is securely retained in place until selectively actuated as desired. The retaining body **20** may be actuated to remove and replace the fastener **70** on the pin member **64** as often as desired, with the body providing consistent, secure, and reliable retention of the fastener in every instance.

[0034] It will be appreciated by those skilled in the art that embodiments of this disclosure can be made completely with non-metallic components. Conventional plastics (e.g., synthetics, composites, etc.) can be used to produce the components for embodiments of this disclosure, including non-metallic springs and locking balls. Such embodiments not only reduce weight, they are also more durable as they are corrosion resistant and can be used in high moisture environments without need for special coatings or enclosures. Embodiments may also be produced using binder jetting additive manufacturing (3D printing). Embodiments of this disclosure can also be made completely with metallic components. For example, ring **60** components can be produced with hinged arch sections and coupling clasps as known in the art. Yet other embodiments may be produced with a mixture of metallic and non-metallic components. For example, embodiments may be implemented with composite bodies **20** and rings **60** in combination with metallic springs **62**A, **62**B and locking balls **68**. In light of the example embodiments described and illustrated herein, it will be recognized that numerous modifications could be applied to derive alternative embodiments of the present invention. Embodiments of this disclosure may be implemented for use with fasteners and/or pin members of different dimensions, shapes, and sizes as known in the art. What is claimed as the invention, therefore, are all implementations that come within the scope of the following claims.

Claims

1. A fastener retention apparatus comprising: a body having a cavity to receive a fastener; the body having a ring disposed thereon, wherein the ring is configured for rotation on the body such that at

least one locking ball transitions between an engagement position and a disengagement position within an orifice on the body for selective rotation of the fastener.

2. The fastener retention apparatus of claim 1 wherein the ring is configured with at least one spring to provide a biasing force against the rotation of the ring on the body.

3. The fastener retention apparatus of claim 1 wherein the body is configured with an opening to receive a pin member configured to pass through the fastener on the body.

4. The fastener retention apparatus of claim 3 wherein the pin member is configured with at least one void formed thereon to receive the at least one locking ball.

5. The fastener retention apparatus of claim 4 wherein the pin member is configured with threads to engage with the fastener.

6. The fastener retention apparatus of claim 1 wherein the body and/or the ring are each formed of a non-metallic material.

7. The fastener retention apparatus of claim 1 wherein the ring is configured with a plurality of springs to provide a biasing force against the rotation of the ring on the body and a plurality of locking balls configured for transition between an engagement position and a disengagement position within orifices on the body.

8. The fastener retention apparatus of claim 1 wherein the ring is formed of multiple pieces configured to couple to one another.

9. The fastener retention apparatus of claim 1 wherein the ring is configured with at least one protrusion formed on an external surface thereof.

10. The fastener retention apparatus of claim 2 wherein the body is configured with at least one detent to provide a resistance to the at least one spring.

11. The fastener retention apparatus of claim 1 wherein the cavity is configured to receive a fastener consisting of a nut with internal threads.

12. The fastener retention apparatus of claim 11 wherein the body is configured with an opening to receive a pin member consisting of a bolt configured to engage the nut.

13. The fastener retention apparatus of claim 12 wherein the body is configured to prevent rotation of the nut relative to the bolt when the at least one locking ball is in the engagement position.

14. The fastener retention apparatus of claim 1 wherein the ring is configured with at least one void on an inner surface thereof to receive the at least on locking ball.

15. The fastener retention apparatus of claim 1 wherein the ring is configured with a first spring to provide a biasing force against rotation of the ring in a first direction, and a second spring to provide a biasing force against rotation of the ring in a second direction.

16. A method of retaining a fastener, comprising: disposing a fastener on a body having a cavity to receive the fastener; and selectively rotating the fastener by rotating a ring disposed on the body such that at least one locking ball transitions between an engagement position and a disengagement position within an orifice on the body.

17. The method of claim 16 wherein the body and/or the ring are each formed of a non-metallic material.

18. The method of claim 16 wherein the ring is configured with at least one spring to provide a biasing force against the rotation of the ring on the body.

19. The method of claim 16 wherein the body is configured with an opening to permit a pin member to pass through the fastener on the body.

20. The method of claim 19 further comprising disposing the body on a pin member configured with at least one void formed thereon to receive the at least one locking ball.