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Ball joint system and support device

Abstract

A firearm maintenance aid can include a firearm vise and a firearm support device. Firearm vise can include vise jaws, a threaded rod connecting vise jaws together, and jaw pin holes in each jaw, the holes extending from an outer surface of a jaw through to an inner surface of each jaw, wherein the holes in the first jaw align with the holes in the second jaw. Firearm support device can include a clamping portion and a supporting portion. The clamping portion can be clamped between the jaws of the firearm vise, can include two parallel clamping faces, and can define vise pin holes that align with the jaw pin holes. The supporting portion can be located opposite the clamping portion and can include a cylindrical shaft. Vise pins can be received by the jaw pin holes and vise pin holes to fixedly connect the support device to the vise.

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Background/Summary

FIELD OF THE INVENTION

(1) This disclosure relates to ball joint systems, and more particularly, relates to vises that have ball joint systems.

BACKGROUND OF THE INVENTION

(2) During maintenance activities, devices like firearms (or sub-components thereof) are often held or otherwise supported by clamps, jigs, vises, or other mechanical support arrangements. This can free up an armorer's hands for performing maintenance tasks and can enable greater application of torque to components than, for example, handholding. In some cases, however, access to portions of the object being worked upon while using a traditional vise is difficult because the portion of the object being worked upon may not be easily accessible to a user when the object is secured in the vise. Additionally, vises that offer various repositioning options, are inefficient to use. Therefore, it is desirable to provide a vise that can provide secure support for objects being worked upon and can offer the ability for efficient repositioning during maintenance activities.

SUMMARY OF THE INVENTION

(3) This disclosure relates to ball joint systems, and more particularly, relates to vises that have ball joint systems. In an illustrative but non-limiting example, the disclosure provides a ball joint system that can include a plurality of vise jaws and a vise base having a housing and a ball joint. The vise base can connect to the vise jaws via the ball joint. The ball joint can include a ball that is located at least partially within the housing, a stem connected on a first end to the ball and on a second end to a portion of the vise jaws, and a ball lock for securing the ball in a predetermined position within the housing. Further, the ball can include one or more passages through which the ball lock can be inserted to lock the ball in a predetermine position, and the one or more passages can be located at least partially along a bottom surface of the ball.

(4) In some cases, the one or more passages can be at least partially open channels along an exterior surface of the ball such that at least a portion of

the ball lock, when inserted into one of the one or more passages, is located directly between the passage and an interior of the housing. In some cases, the one or more passages can be two passages that have surfaces that intersect each other. Further, the one or more passages can be perpendicularly arranged.
(5) In some cases, the one or more passages can extend completely through the ball, and the housing can include a plurality of ball lock holes in at least two sides of the housing, enabling the ball lock to enter into one of the plurality of ball lock holes on one side of the housing and exit out the opposite side. Further, the plurality of ball lock holes can comprise at least two ball lock holes with an entrance for each ball lock hole on a first side of the housing and an exit for each ball lock hole on a second side of the housing, and the ball can be positioned between the entrances and exits of the two ball lock holes. Additionally, the plurality of ball lock holes can further comprise at least one storage hole with an entrance on a first side of the housing and an exit on the second side of the housing, and the ball may not be positioned between the entrance and exit of the storage hole.
(6) In some cases, the ball joint system can further include two inserts, wherein each insert can be attached to a corresponding inner face of the vise jaws, can include a cutout along a top edge, and can be reversible. Sometimes, the ball joint system can further include a cam latch wherein the cam latch can be comprised of a lever and a threaded rod, and the housing can include a threaded receiving cavity for receiving the threaded rod. In some cases, the ball joint system can further include a clamp base attached to the vise jaws.
(7) In another illustrative but non-limiting example, the disclosure provides a ball joint system comprising a base having a housing, and a ball joint. The ball joint can include a ball located at least partially within the housing, a stem connected on a first end to the ball, and a ball lock for securing the ball in a predetermined position within the housing. Further, the ball can include one or more passages that can be structured and configured to pair with the ball lock in a predetermined locking position. The one or more passages can be located at least partially along a bottom of the ball and can be at least partially open along an exterior surface of the ball such that at least a portion of the ball lock, when located in one of the one or more passages, can be located between the passage and the interior of the housing. In some cases, the one or more passages can be two passages that have surfaces that intersect each other and are perpendicularly arranged.
(8) In some cases, the one or more passages can extend completely through the ball, and the housing can include a plurality of ball lock holes in at least two sides of the housing, enabling the ball lock to enter into one of the plurality of ball lock holes on one side of the housing and exit out the opposite side. Further, the plurality of ball lock holes can comprise at least two ball lock holes with an entrance for each ball lock hole on a first side of the housing and an exit for each ball lock hole on a second side of the housing, and the ball can be positioned between the entrances and exits of the two ball lock holes. Additionally, the plurality of ball lock holes can further comprise at least one storage hole with an entrance on a first side of the housing and an exit on the second side of the housing, and the ball may not be positioned between the entrance and exit of the storage hole.
(9) In some cases, the ball joint system further includes a plurality of vise jaws that connect to a second end of the ball joint stem. Additionally, the ball joint system may include two inserts, wherein each insert is attached to a corresponding inner face of the vise jaws. In some cases, the ball joint system can further include a cam latch wherein the cam latch is comprised of a lever and a threaded rod, and the housing includes a threaded receiving cavity for receiving the threaded rod.
(10) In another illustrative but non-limiting example, the disclosure provides a method of using a ball joint system comprising aligning a passage in a ball with a ball lock hole, inserting a ball lock into the ball lock hole of a housing, inserting the ball lock into the passage of the ball to lock the ball at a predetermined angle, and clamping an object between vise jaws. The ball can be part of a ball joint, the ball lock hole can be in a side of the housing, and the housing can house the ball. Further, the vise jaws can be attached to a first end of a ball stem of the ball. In some cases, the method can further comprise the steps of twisting a lever of a cam latch in a first direction to move two halves of the housing closer to each other and rotating the lever upward to further secure the ball in place.
(11) The above summary is not intended to describe each and every example or every implementation of the disclosure. The Description that follows more particularly exemplifies various illustrative embodiments.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The following description should be read with reference to the drawings. The drawings, which are not necessarily to scale, depict examples and are not intended to limit the scope of the disclosure. The disclosure may be more completely understood in consideration of the following description with respect to various examples in connection with the accompanying drawings, in which:
(2) FIG. **1** is a schematic perspective view of an illustrative example of a portion of a vise tool;
(3) FIG. **2** is a schematic plan view of the vise tool of FIG. **1**;
(4) FIG. **3** is a schematic perspective view of an illustrative example of a vise tool;
(5) FIG. **4** is a schematic perspective view of a firearm support device clamped in the vise tool of FIG. **3**;
(6) FIG. **5** is a schematic perspective view of a firearm support device clamped in the vise tool of FIG. **3**;
(7) FIG. **6** is a schematic front view of a portion of the vise tool of FIG. **1**;
(8) FIG. **7** is a schematic perspective view of a portion of a ball joint of the vise tool of FIG. **1**;
(9) FIG. **8** is a schematic cross-sectional side view of the portion of the vise tool of FIG. **6** taken from the line **8**-**8** in FIG. **6**;
(10) FIG. **9** is a schematic plan view of a firearm support device clamped in the vise tool of FIG. **3**;
(11) FIG. **10** is a schematic side view of the vise tool of FIG. **1**; and
(12) FIG. **11** is a schematic perspective view of the vise tool of FIG. **1**.
DETAILED DESCRIPTION
(13) The present disclosure relates to ball joint systems, and more particularly, relates to vises that have ball joint systems. Various embodiments are described in detail with reference to the drawings, in which like reference numerals may be used to represent like parts and assemblies throughout the several views. Reference to various embodiments does not limit the scope of the systems and methods disclosed herein. Examples of construction, dimensions, and materials may be illustrated for the various elements, those skilled in the art will recognize that many of the examples provided have suitable alternatives that may be utilized. Any examples set forth in this specification are not intended to be limiting and merely set forth some of the many possible embodiments for the systems and methods. It is understood that various omissions and substitutions of equivalents are contemplated as circumstances may suggest or render expedient, but these are intended to cover applications or embodiments without departing from the spirit or scope of the disclosure. Also, it is to be understood that the phraseology and terminology used herein are for the purpose of description and should not be regarded as limiting.
(14) Various known maintenance support devices demonstrate shortcomings that limit their usefulness. Some of these devices only provide for supporting objects in very specific or limited orientations, and some such devices only include minimal features to accommodate clamping by a vise. The present disclosure provides ball joint systems and support devices that can robustly and flexibly support devices, such as firearms, in various orientations according to a user's preference. The ball joint systems and support devices are a maintenance aid that can be used to help a user securely and efficiently clean, maintain, assemble, and disassemble devices such as firearms.
(15) Firearm vise **200**, as illustrated in FIG. **1**, may include a plurality of vise jaws **202** that each have a plurality of jaw pin holes **204**. Vise jaws **202** may be connected to each other by threaded rod **206** and may be comprised of first jaw **202***a* and second jaw **202***b*. Further, jaw pin holes **204** in one or both of vise jaws **202** may extend from outer surface **208** of the vise jaw through to inner surface **210** of the vise jaw. In some embodiments, some or all of jaw pin holes **204** in first jaw **202***a* can align with some or all of the jaw pin holes in second jaw **202***b*. Therefore, when a vise pin is inserted

into vise jaws **202**, it can insert into both first jaw **202***a* and second jaw **202***b* via the aligned jaw pin holes **204**.

(16) In some embodiments, vise jaws **202** may have relatively flat inner faces, and the flat inner faces may be textured to increase friction with a clamped component, such as firearm support device **100**. However, a textured surface is not necessary for vise jaws **202** to securely clamp a component, as is described in detail below. Therefore, the inner face of each vise jaw **202** may, alternatively, be smooth. In some cases, inner faces **210** of vise jaws **202** may be parallel to each other and may be mirror images of each other such that when they are moved together so that the inner faces touch, the entire surface of one inner face touches the entire surface of another. However, in other embodiments, the inner faces may have slightly different dimensions and/or sizes such that one is smaller or larger than the other. In addition to inner faces, vise jaws **202** have top and side edges, which may be flat and angled 90 degrees from inner faces **210**, as illustrated in FIGS. **1**-**5** and **10**-**11**, as well as outer faces **208**, which may be flat or decoratively patterned. Further, the outer face may be parallel to the inner faces or may slope outward from the top to the bottom, as illustrated in FIGS. **1**-**2** and **10**.

(17) As mentioned above, vise jaws **202** may not need a textured surface to securely clamp a component in place. To accomplish a secure clamp, vise jaws **202** may have a plurality of jaw pin holes **204** into which vise pins **212** can be inserted to lock a clamping component, such as firearm support device **100** having vise pin holes (not shown), in place. Additionally, jaw pin holes **204** in vise jaws **202** may align with each other to enable a vise pin to pass from one vise jaw through to another. More specifically, jaw pin holes **204** may be located in both vise jaws **202***a/b* and aligned with each other such that one vise pin **212** can be simultaneously connected to a jaw pin hole in each vise jaw. In some embodiments, jaw pin holes **204** may pass from outer surface **208** to inner surface **210** of one or both vise jaws **202**. For example, as illustrated in FIGS. **4** and **9**-**11**, first vise jaw **202***a* may have jaw pin holes **204** that pass from outer surface **208** to inner surface **210** and second vise jaw **202***b* may have jaw pin holes that are only open to its inner surface. Therefore, when firearm support device **100** is clamped into firearm vise **200**, vise pins **212** can be inserted from outer surface **208** of vise pin holes **204** of first vise jaw **202***a* and through to inner surface **210**, through the support device, and into vise pin holes **204** on the inner surface of second vise jaw **202***b* where they can be stopped by the remaining solid material of the second vise jaw. While vise pin holes **204** are illustrated herein on outer surface **210** of first vise jaw **202***a*, it is noted that first vise jaw **202***b* can have vise pin holes **204** that penetrate from the outer surface through to the inner surface as well.

(18) In some embodiments, jaw pin holes **204** may horizontally align with each other on each vise jaw **202**. For example, as illustrated in FIGS. **3**-**4** and **11**, two holes from vise jaw **202** may be aligned along a horizontal line such that they are the same distance from the top and/or bottom of first vise jaw **202***a*. This allows the component to be locked in a parallel configuration to inner faces **210** of vise jaws **202**, as illustrated in FIGS. **4**-**5**. Other jaw pin hole configurations may include two holes aligned along a vertical line such that when firearm vise **200** is upright, the first hole is directly above, or below, the second hole, and the component can be locked perpendicular, or 90 degrees, to inner faces **210**. These are not the only alignments or configurations that may be possible. Further alignments or configurations can include any angle such as, but not limited to, jaw pin holes that allow for the component to be locked at a 30-degree angle, a 45-degree angle, and a 60-degree angle to the inner face. There may be several jaw pin holes in each vise jaw such that any or all of the above-mentioned hole configurations are accessible to a user. For example, in one embodiment, each vise jaw may have four vise pin holes, wherein two of the vise pin holes vertically align on one half of the vise jaw, two of the vise pin holes vertically align on another half of the vise jaw, the top two vise pin holes are horizontally aligned with each other, the bottom two vise pin holes are horizontally aligned with each other, and the bottom vise pin holes and their opposite side, top vise pin hole are in 45-degree alignment.

(19) Vise pins **212** may be structured and configured to be received by any of the plurality of the vise pin holes of clamping portion **106** of firearm support device **100** as well as by any of the plurality of jaw pin holes **204** of vise jaws **202**, such that the vise pins are elongate and cylindrical in form and the vise pin holes are similarly shaped and dimensioned to enable a friction fit. More specifically, the external circumference of vise pins **212** may be substantially equivalent, albeit slightly smaller, to the internal circumference of the vise pin holes and jaw pin holes **204**. Vise pins **212** may be inserted from the outer surface of vise jaw **202**, thereby allowing user to clamp component between the vise jaws prior to inserting the vise pins. Further, as discussed more below, if the clamped component, such as firearm support device **100**, has pin holes, the clamped component may first be secured between vise jaws **202** and then vise pin **212** can be inserted into one vice jaw, through the clamped component, and into second jaw. If two or more vise pins **212** are used, this can lock the clamped component securely in place for the user to work with. So positioned, the vise pins **212** can serve to define and to assist in maintaining a working angle for the clamped component (for example, firearm support device **100**). In some embodiments, the vise pins may be simple cylindrically shaped pins. Alternatively, vise pins **212** may have a head or grip on one end of a cylindrical shaped pin portion, as illustrated in FIGS. **4** and **9**-**10**, to offer users a more ergonomic grip when placing the vise pin through vise jaws **202** and the clamped component. The head or grip may be textured or smooth and may have any ergonomic shape such as an elongated mushroom head, ball, or any other grab point.

(20) To clamp vise jaws **202** on a clamping component, such as firearm support device **100**, second jaw **202***b* may be moveable relative to first jaw **202***a*, such that the second jaw can move toward and away from the first jaw along threaded rod **206**. More specifically, vise jaws **202** may further include bases **220**, **222**, and the bases may house threaded rod **206**, allowing for inner faces **210** of the vise jaws to be free from interference of the threaded rod when clamping onto a component. For example, first jaw **202***a* may be connected to, or molded from the same part as, clamp base **220**, and second jaw **202***b* may be connected to, or molded from the same part as, jaw base **222**. Therefore, jaw base **222** may connect to clamp base **220** via threaded rod **206**, enabling second jaw **202***b* to move relative to first jaw **202***a*. To enable rotation of threaded rod **206** and movement of one vise jaw toward another, the threaded rod may have a screw head attached on one end. For example, screw head **214** may be attached to threaded rod **206** on an outer portion of jaw base **222** of second jaw **202***b*, as illustrated in FIGS. **1**-**3** and **10**-**11**. Further, screw head **214** may have an aperture through which handle **216** is inserted. In some cases, screw head **214** and handle **216** may be one singular molded part and in other cases, they may be separate parts. Handle **216** can be elongated and rigid, such that it will not bend or flex when human pressure is applied to the handle. Additionally, handle **216** may be straight, as illustrated, or have curvature, which can provide an ergonomic grip to user. When handle **216** is turned, it can cause rotation of screw head **214**, which can cause rotation of threaded rod **206**. Rotation of threaded rod **206** can then cause second jaw **202***b* to move toward or away from first jaw **202***a*. For example, clockwise rotation of threaded rod **206** may cause second jaw **202***b* to move toward first jaw **202***a*, while counterclockwise rotation of the threaded rod may cause second jaw to move away from first jaw.

(21) In addition to threaded rod **206**, jaw base **222** may also be connected to clamp base **220** via one or more guide bars **218**. Guide bars **218** may be smooth so as not to provide friction when second jaw **202***b* moves toward first jaw **202***a*. Further, guide bars **218** may be cylindrical, as illustrated in FIGS. **3**-**4**, or may have another shape such as rectangular or pyramidal, and they may offer additional support for when heavy components are clamped between vise jaws **202**. This additional support may keep vise jaws **202** from becoming misaligned if they are twisted due to torque applied during use of firearm vise **200**, and the support may also prevent threaded rod **206** from bending due to having to withstand too much torque. In some embodiments, as illustrated in FIG. **2**, firearm vise **200** may include two guide bars **218** that are parallel to, and on opposite sides of, threaded rod **206**.

(22) In some embodiments, vise jaws **202** may each have a ledged, upper recess on inner faces **210** such that each vise jaw is compatible with insert **224**. Insert **224** may be approximately rectangular with flat inner and outer faces, which may be parallel to each other, may have top long edge **226** and bottom long edge **228**, and the upper recess in vise jaws **202** may be approximately the same size and shape as the insert such that when the insert is attached to the vise jaw, the side and upper edges of both the vise jaw and the insert align and the inner faces are on the same plane. In some cases, the inner face of insert **224** may be textured (for example, knurled) and the outer face of the insert may be smooth, although this is not required and either or both faces may be textured or smooth. If the outer face of insert **224** is smooth, the surface of the ledged, upper recess may also be smooth to prevent gaps between the insert and the upper recess when they are connected together. Since insert **224** may be removable, an attachment mechanism can be used to keep the insert connected to vise jaw **202**. More specifically, vise jaw **202** and insert **224** may be attached or connected

using connections such as, but not limited to, screws **232**, as illustrated in FIGS. **1** and **3**, snap fit connections, or dove tail connections.
(23) Insert **224** may have cutout or recess **230** along top long edge **226** or bottom long edge **228** that is roughly rectangular. In some embodiments, the cutout/recess is through the entire insert, thereby causing the insert to have a u-shape. In other embodiments, cutout/recess **230** is only a portion of a long edge such that the back of insert **224** remains a complete rectangle, as illustrated in FIGS. **1**, **3**, **9**, and **11**. Further, insert **224** may be reversible and, if so, cutout/recess **230** along top long edge **226** may appear to be along a top portion when insert is in one configuration and it may appear to be along a bottom portion when insert is rotated 180 degrees into a reversed configuration.
(24) In some embodiments, if jaw pin holes **204** are located in the region of vise jaws **202** where insert **224** attaches, then in order to retain the securing function of vise pins **212** when the insert is attached to the vise jaw, the insert can have insert pin holes that align with jaw pin holes **204**. More specifically, the insert pin holes may be positioned such that they align with jaw pin holes **204** regardless of whether insert **224** is upright or upside down. For example, the insert pin holes may be located in the center of the insert. In other embodiments, the insert may have a first set of holes that align with jaw pin holes **204** in a first configuration and a second set of holes of that align with the jaw pin holes when the insert is in the reversed configuration. However, to simplify the design of firearm vise **200**, jaw pin holes **204** may be located beneath the connection region of insert **224** with vise jaws **202**, as illustrated in FIG. **3**.
(25) In addition to connecting to first vise jaw **202***a*, clamp base **220** may also include, and be controlled by, leveling knob **234**, which may also indirectly control jaw base **222** via its attachment to the clamp base vis-a-vis threaded rod **206**. Leveling knob **234** may include a pin/rod (not shown), a spring (not shown), and knob **236** connected to an outer end of the pin/rod. The pin/rod may be locked within clamp base **220** when leveling knob **234** is in its home position. Then, when knob **236** is pulled out, the spring can be compressed, the pin/rod can be pulled out and removed from its home position, and leveling knob **234** may be able to rotate left or right. This left or right rotation can rotate vise jaws **202** a few degrees in one direction or another, which may help to level the vise jaws and the clamped component, such as firearm support device **100**, for maintenance or other work. In some cases, when leveling knob **234** is rotated, the pin/rod is structured and configured such that it is prevented from locking back into its home position. However, leveling knob **234** may still provide enough friction and/or pressure to keep vise jaws **202** level until the user resets the leveling knob back into its home position.
(26) In some embodiments, firearm vise **200** may include vise base **238**, which can connect to vise jaws **202** via clamp base **220**, as illustrated in FIGS. **3-5** and **10-11**. Vise base **238** may be used to mount firearm vise **200** to a flat surface such as a workbench or table and may include housing **240**, table mount **242**, and a table clamp (not shown). Connection of vise base **238** to vise jaws **202** (via clamp base **220**, for example) may be via ball joint **244**, which can include ball **246**, stem **248**, ball lock **250**, and/or cam latch **252**, as illustrated in FIG. **3**. Alternatively, connection of vise base **238** to clamp base **220** can also take place by a fixed connection component such as, but not limited to, a rod, neck, or post. Connection by ball joint **244** may allow for fewer jaw pin holes **204** since vise jaws **202** can move the clamped component, such as firearm support device **100**, into many positions, angles, and configurations due to the flexibility of the ball joint, whereas connection by a fixed connection component may be more compatible with embodiments of the vise jaws that include additional jaw pin holes since the additional jaw pin holes will enable the clamped component to be moved into more than one secured position.
(27) Housing **240** of vise base **238** may be comprised of one or more parts. In embodiments having ball joint **244** as a connection mechanism between vise base **238** and clamp base **220**, housing **240** can have at least two parts, such as top portion **254** and bottom portion **256**, to aid in assembly and, as mentioned in more detail below, locking of the ball joint via a clamping mechanism. In embodiments having a fixed connection component, the housing may be limited to one piece. Housing **240** may be either connected to table mount **242** or may be a continuous piece with the table mount such that they are not removable from each other. In some cases, housing **240** may have a top portion separate from a bottom portion and the bottom portion may be one continuous piece with table mount **242**. Other configurations are possible.
(28) As mentioned above, table mount **242** and the table clamp (not shown) can secure firearm vise **200** to a flat, working surface such as a workbench or table. Therefore, table mount **242** may have a flat bottom face to increase the amount of surface area in contact with the working surface and to allow for a secure mount to the working surface. The top of table mount **242** may also be flat or may have additional features. For example, the top of table mount **242** may include storage trays, cavities, or pockets **258** for holding tools or firearm parts. In some embodiments, the top of table mount may include recessed portion **260** that is structured and configured to receive a portion of table clamp. Further, housing **240** may connect to table mount **242** along a central portion such that the table mount may have recessed portion **260** on either side of the central portion, as illustrated in FIGS. **4** and **9**. This allows for two table clamps to secure table mount **242** to the working surface. More specifically, the table clamp may be a c-clamp and a top arm of the table clamp may nest into recessed portion **260** on table mount **242**. This recessed portion may be smooth, or it may have a texture so as to increase friction and prevent unwanted sliding between table mount **242** and a table clamp. Another method for connecting table mount **242** to a work surface is via screws, as illustrated in FIG. **3**. More specifically, recessed portion(s) **260** may include holes or openings into which screws **262** can be inserted. Further, table mount **242** may have connection point **264** specifically structured and configured for screw **262**, as further illustrated in FIG. **3**, wherein the connection point is a recessed portion that is smaller than recessed portion **260** and shaped more similarly to a screw head.
(29) As mentioned above, housing **240**, in addition to connecting to table mount **242**, can connect to a connection component, such as ball joint **244**, to connect vise base **238** to clamp base **220**. As illustrated in FIGS. **3**, **6** and **11**, ball joint **244** may include ball **246**, stem **248**, and ball lock **250**, wherein the stem can be connected on a first end to the ball and on a second end to a portion of vise jaws **202** (for example, clamp base **220**), and the ball lock can secure the ball in one or more predetermined positions. Ball **246** may be located at least partially within housing **240** or, alternatively, may be completely surrounded by the housing.
(30) In some embodiments, ball **246** may be comprised of one or more passages **266** through which ball lock **250** can be inserted in order to lock the ball in a predetermined position, although in some cases, vise pin **212** and ball lock **250** may be interchangeable so the vise pin may be used instead of the ball lock. More specifically, ball **246** can include two passages **266** that may be located at least partially along a bottom surface of the ball (i.e., opposite the side of the ball that connects to stem **248**), may be perpendicular to each other, and may have surfaces that intersect or cross through each other, as illustrated in FIG. **7**. Passages **266** may not be entirely internal to ball **246** and at least a portion of the length of each passage may be partially open to the inner surface of housing **240** (for example, a portion of the passage may be a channel that is at least partially open along an exterior surface of the ball) such that at least a portion of ball lock **250** (for example, a lengthwise side of the ball lock), when inserted into a passage, is not completely surrounded by the ball and may be exposed to the interior of the housing. More specifically, the part of ball lock **250** that is in the option portion of passage **266** can be located directly between the surface of the passage and the interior of housing **240**. In some embodiments, passage **266** may be completely open such that the portion of ball lock **250** within housing **240**, when inserted into the passage, is located directly between the surface of passage **266** and the interior of the housing. Further, passages **266** may extend completely through ball **246**, as illustrated in FIG. **7**, or, alternatively, may extend partway into the ball but end prior to reaching the opposite side of the ball.
(31) Since ball **246** can be located within housing **240**, the housing may, further, include a plurality of ball lock holes **268** in, for example, at least one side of the housing into which ball lock **250** can be inserted to gain access to passages **266**. Ball lock **250** can be elongate and cylindrical in form and ball lock holes **268** can be similarly shaped and dimensioned (i.e., also elongate and cylindrical in form) such that the ball lock can securely fit in a ball lock hole. One embodiment may include at least two ball lock holes **268** in at least one side of housing **240**. For example, there may be three ball lock holes **268** in two sides of housing **240** (for example, two opposing sides), as illustrated in the figures. These ball lock holes **268** can enable ball lock **250** to enter into one of the ball lock holes on one side of housing **240** and, in some embodiments, exit out the opposite side of the housing, as illustrated in FIG. **6**. More specifically, each ball lock hole may have an entrance on a first side of housing **240** and an exit on a second, opposite side of the housing.

(32) Further, in some embodiments, at least two ball lock holes **268** are configured such that ball **246** is positioned between the entrances and exits of the at least two ball lock holes and ball lock **250**, when inserted into the at least two ball lock holes **268** also inserts into one of passages **266**. Additionally, a third ball lock hole (for example, the hole closest to cam latch **252** in FIG. **3**) can be positioned such that ball **246** is not positioned between the entrance and exit of the third ball lock hole. This third ball lock hole **246** may be used as a storage hole when ball lock **250** is not in use. Therefore, the storage hole is positioned apart from ball **246**, as illustrated in FIG. **8**, such that insertion of ball lock **250** into the storage hole results in no physical contact with the ball, and the ball lock does not insert into any of passages **266**.
(33) Further, as mentioned above, ball **246** can include one or more passages **266** that are structured and configured to pair with ball lock **250** in one or more predetermined locking positions. For example, one embodiment of the device can include two perpendicular passages in ball **246**, as illustrated in FIG. **7**, that, in combination with ball lock holes **268**, enable ball lock **250** to secure ball joint **244** in one of eight positions: vertical and facing forward, left, right, or back when the ball lock is inserted through, for example, a middle ball lock hole (i.e., a ball lock hole approximately centered in the housing), and horizontal and facing forward, left, right, or back when the ball lock is inserted through a back ball lock hole (i.e., a ball lock hole nearest to vise base **238**). The top of housing **240** may include recessed passages **270** near its front and back to accommodate stem **248** of ball joint **244** when the ball joint is in a horizontally forward or angled backward position, respectively.
(34) In addition to ball lock **250**, which can be used to lock ball **246** securely in place when high amounts of torque may be applied to vise jaws **202**, ball joint **244** may include cam latch **252** for securing the ball within housing **240** in additional positions that are not compatible with ball lock holes **268** and the ball lock. Cam latch **252** may help connect top and bottom of housing **254**, **256** and can be used to lock ball **246** in any position by compressing the top and bottom of the housing onto the ball. More specifically, cam latch **252** can include lever **272** and threaded rod **274**, and top and bottom of housing **254**, **256** can have a threaded receiving cavity for receiving the threaded rod. To secure ball **246** in housing **244**, lever **272** can be twisted (for example, counterclockwise), thereby turning threaded rod **274** within the threaded receiving cavity and pulling top and bottom of housing **254**, **256** toward each other and tightening housing **240** around the ball. Lever **272** of cam latch **252** can then be rotated upward 90 degrees to lock in place, which prevents countertwisting of threaded rod **274** and adds additional compression to ball **246**. To loosen ball **246**, lever **272** can be straightened, rotated in the opposite direction (for example, clockwise), thereby turning threaded rod **274** within the threaded receiving cavity in the opposite direction and allowing top and bottom of housing **254**, **256** to separate from each other and from the ball.
(35) Persons of ordinary skill in arts relevant to this disclosure and subject matter hereof will recognize that embodiments may comprise fewer features than illustrated in any individual embodiment described by example or otherwise contemplated herein. Embodiments described herein are not meant to be an exhaustive presentation of ways in which various features may be combined and/or arranged. Accordingly, the embodiments are not mutually exclusive combinations of features; rather, embodiments can comprise a combination of different individual features selected from different individual embodiments, as understood by persons of ordinary skill in the relevant arts. Moreover, elements described with respect to one embodiment can be implemented in other embodiments even when not described in such embodiments unless otherwise noted. Although a dependent claim may refer in the claims to a specific combination with one or more other claims, other embodiments can also include a combination of the dependent claim with the subject matter of each other dependent claim or a combination of one or more features with other dependent or independent claims. Such combinations are proposed herein unless it is stated that a specific combination is not intended. Furthermore, it is intended also to include features of a claim in any other independent claim even if this claim is not directly made dependent to the independent claim.
(36) Any incorporation by reference of documents above is limited such that no subject matter is incorporated that is contrary to the explicit disclosure herein. Any incorporation by reference of documents above is further limited such that no claims included in the documents are incorporated by reference herein. Any incorporation by reference of documents above is yet further limited such that any definitions provided in the documents are not incorporated by reference herein unless expressly included herein.

Claims

1. A ball joint system comprising: a plurality of vise jaws; and a vise base having a housing and connected to the vise jaws via a ball joint, wherein the ball joint includes a ball located at least partially within the housing, a stem connected on a first end to the ball and on a second end to a portion of the vise jaws, and an elongate ball lock for securing the ball at a predetermined angle within the housing to prevent rotation of the ball, wherein the ball includes one or more passages through which the ball lock is inserted to lock the ball in a predetermined position, the one or more passages being located at least partially along a bottom surface of the ball, wherein the one or more passages extend completely through the ball, and wherein the housing includes a plurality of ball lock holes in at least two sides of the housing, enabling the ball lock to enter into one of the plurality of ball lock holes on one side of the housing and exit out the opposite side.
2. The ball joint system of claim 1, wherein the one or more passages are at least partially open channels along an exterior surface of the ball such that at least a portion of the ball lock, when inserted into one of the one or more passages, is located directly between the passage and an interior of the housing.
3. The ball joint system of claim 1, wherein the one or more passages are at least two passages that have surfaces that intersect each other.
4. The ball joint system of claim 3, wherein the at least two passages comprise two passages that are perpendicularly arranged.
5. The ball joint system of claim 1, wherein the plurality of ball lock holes comprise at least two ball lock holes with an entrance for each ball lock hole on a first side of the housing and an exit for each ball lock hole on a second side of the housing, and wherein the ball is positioned between the entrances and exits of the two ball lock holes.
6. The ball joint system of claim 5, wherein the at least two ball lock holes further comprise at least one storage hole with an entrance on a first side of the housing and an exit on the second side of the housing, and wherein the ball is not positioned between the entrance and exit of the storage hole.
7. The ball joint system of claim 1, further comprising two inserts, wherein each insert is attached to a corresponding inner face of the vise jaws, includes a cutout along a top edge, and is reversible.
8. The ball joint system of claim 1, further comprising a cam latch wherein the cam latch is comprised of a lever and a threaded rod, and the housing includes a threaded receiving cavity for receiving the threaded rod.
9. The ball joint system of claim 1, further comprising a clamp base attached to the vise jaws.
10. A ball joint system comprising: a base having a housing; and a ball joint, wherein the ball joint includes a ball located at least partially within the housing, a stem connected on a first end to the ball, and a ball lock for securing the ball at a predetermined angle within the housing to prevent rotation of the ball, and wherein the ball includes one or more passages structured and configured to pair with the ball lock in a predetermined locking position, the one or more passages being located at least partially along a bottom surface of the ball and at least partially open along an exterior surface of the ball such that at least a portion of the ball lock, when located in one of the one or more passages, is located between the passage and an interior of the housing, wherein the one or more passages extend completely through the ball, and wherein the housing includes a plurality of ball lock holes in at least two sides of the housing, enabling the ball lock to enter into one of the plurality of ball lock holes on one side of the housing and exit out the opposite side.
11. The ball joint system of claim 10, wherein the one or more passages are at least two passages that have surfaces that intersect each other and are perpendicularly arranged.
12. A ball joint system of claim 10, wherein the plurality of ball lock holes comprise at least two ball lock holes with an entrance for each ball lock hole on a first side of the housing and an exit for each ball lock hole on a second side of the housing, and wherein the ball is positioned between the entrances and exits of the two ball lock holes.

13. The ball joint system of claim 12, wherein the at least two ball lock holes further comprise at least one storage hole with an entrance on a first side of the housing and an exit on the second side of the housing, and wherein the ball is not positioned between the entrance and exit of the storage hole.
14. The ball joint system of claim 10, further comprising a plurality of vise jaws that connect to a second end of the ball joint stem.
15. The ball joint system of claim 14, further comprising two inserts, wherein each insert is attached to a corresponding inner face of the vise jaws.
16. The ball joint system of claim 10, further comprising a cam latch wherein the cam latch is comprised of a lever and a threaded rod, and the housing includes a threaded receiving cavity for receiving the threaded rod.