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Abstract

A bending tool for bending tubing, the bending tool includes first and second bend bodies that respectively include first and second arcuate channels. A central channel is cooperatively formed between the first and second bend bodies, and tubing partially disposed in the central channel may be bent around either of the first or second bend bodies to impart a desired bend. An attachment may be provided on the bending tool for releasably coupling the bending tool to another tool.

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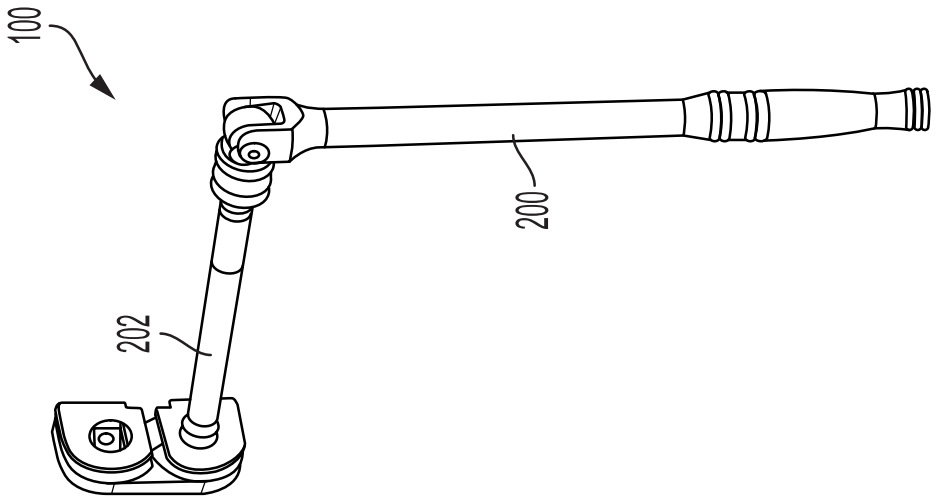

FIG. 6B

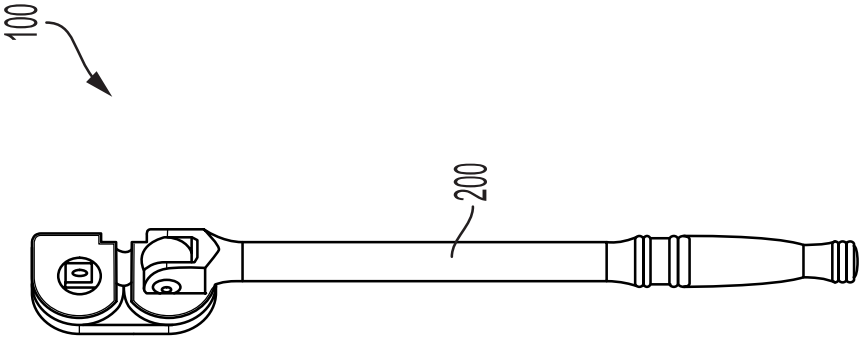

FIG. 6A

BENDING TOOL

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates generally to bending tools, and more particularly, to bending tools that operate in constrained spaces.

BACKGROUND OF THE INVENTION

[0002] Bending metal tubing for a vehicle, such as, for example, brake or gas lines, must often contend with a variety of obstacles and constraints, such as exhaust routing and fuel tank mounting beneath the vehicle that prevent access to the structures that are to be bent. Due to tubing routes around these obstacles, the tubing must be installed and bent along the routing, which prevents bending tubing before installation. Moreover, bending the tubing without marring the surface finish or collapsing/kinking the tube are both concerns, as well as being able to route the tubing around obstructions and keep the tubing within the routing path.

[0003] Current bending tools typically fix a portion of the tubing into the tool and bend the tubing around a mandrel, either by moving the mandrel or moving a mobile portion of the tool relative to the mandrel. This requires planning on where to position the bending tool relative to the tubing and often additional components of the vehicle must be removed to make space available to perform the bending operation due to the size and multiple components of existing bending tools.

SUMMARY OF THE INVENTION

[0004] The present invention relates broadly to a bending tool having an external geometry adapted to bend tubing to various bend angles. The bending tool includes a central channel and two bend bodies. A portion of the tubing may be disposed in the central channel, and another portion of the tubing may be bent around the bend bodies. The central channel provides support for the tubing during the bending process, preventing it from sliding or deforming in an undesired manner. The tubing may be bent around arcuate channels of the two bend bodies that extend from the central channel.

Once the tubing is disposed in the central channel, a user may create bends along the length of the tubing by sliding the tubing in the central channel without removing the tubing from the central channel. The bending tool may also include an attachment for coupling the bending tool to an additional tool, such as a lugged tool, for example a ratchet tool or breaker bar, which may be coupled to the bending tool to provide leverage and positional flexibility for positioning of the bending tool in constrained areas. The position of the attachment on the bending tool allows the bending tool to be used in situations where a traditional handled tool may get in the way, such as bending a tube to include a helical bending profile.

[0005] In an embodiment, the present invention includes a bending tool including a first bend body and a second bend body adapted to couple to the first bend body in a fixed position relative to the first bend body. The first and second bend bodies respectively include first and second arcuate channels, and a central channel is cooperatively formed between the first and second bend bodies and is adapted to receive a tube, wherein the first and second arcuate channels extend from the central channel. An attachment may be provided on at least one of the first or second bend bodies, which is adapted to couple to another tool to provide leverage for moving the bending tool to impart a bend profile on a tube.

[0006] In another embodiment, the present invention includes a bending tool including a first bend body, a second bend body coupled to a second bend body, first and second arcuate channels respectively disposed on the first and second bend bodies, a central channel cooperatively formed between the first and second bend bodies, a base coupled to the first and second bend bodies; and a handle coupled to the base.

[0007] In another embodiment, the present invention includes a bending tool including a base, a first bend body coupled to the base, a second bend body coupled to the base, a central channel cooperatively formed between the first and second bend bodies, and first and second arcuate channels respectively disposed on the first and second bend bodies, wherein the first and second arcuate channels respectively extend along respective circumferences of the first and second bend bodies.

BRIEF DESCRIPTION OF DRAWINGS

[0008] For the purpose of facilitating an understanding of the subject matter sought to be protected, there is illustrated in the accompanying drawing embodiments thereof, from an inspection of which, when considered in connection with the following description, the subject matter sought to be protected, its construction and operation, and many of its advantages, should be readily understood and appreciated.

[0009] FIG. 1 is front view of an exemplar bending tool, according to an embodiment of the present invention.

[0010] FIG. 2 is a sectional front side view of the bending tool of FIG. 1.

[0011] FIG. 3 is an enlarged partial side view of the bending tool of FIG. 1.

[0012] FIG. 4 is a side view of the bending tool of FIG. 1.

[0013] FIG. 5 is an enlarged view of the circled portion of FIG. 4

[0014] FIG. 6A is a perspective view of the bending tool of FIG. 1 coupled with an exemplary handle.

[0015] FIG. 6B is a perspective view of the bending tool of FIG. 1 coupled with an exemplary handle and an extension.

[0016] FIG. 7 is a front view of another embodiment of a bending tool, according to an embodiment of the present invention.

[0017] FIG. 8 is a perspective view of another embodiment of a bending tool, according to an embodiment of the present invention.

[0018] FIG. 9 is a side view of the bending tool of FIG. 8.

[0019] FIG. 10 is a front view of the bending tool of FIG. 8.

[0020] FIG. 11 is a front cross-sectional view of the bending tool of FIG. 8.

DETAILED DESCRIPTION OF THE INVENTION

[0021] While the present invention is susceptible of embodiments in many different forms, there is shown in the drawings, and will herein be described in detail, a preferred embodiment of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to embodiments illustrated. As used

herein, the term “present invention” is not intended to limit the scope of the claimed invention and is instead a term used to discuss exemplary embodiments of the invention for explanatory purposes only.

[0022] The present invention relates broadly to a bending tool having an external geometry adapted to bend bendable tubing with various desired bend angles. The bending tool includes a central channel cooperatively formed between two bend bodies. Tubing may be disposed in this central channel and the central channel provides support for the tubing during the bending process, preventing it from sliding or deforming in an unwanted manner. Once the tubing is disposed in the central channel, a user can bend the unsupported portion of the tubing around one of the bend bodies. Alternately, the tubing may be held in position by a user or otherwise fixed in position, and the bending tool may be rotated to bend a portion of the tubing. The bending tool may include multiple channels by which tubing may be bent. The channels may be sized according to the size of the tubing to be bent. The bending tool may also include an attachment, so an additional tool, such as a lugged ratchet or breaker bar tool, may be releasably coupled to the bending tool to provide increased leverage and positional flexibility for positioning of the bending tool and additional tool in constrained areas.

[0023] Referring to FIGS. 1-5, an exemplary bending tool 100 for bending tubing is illustrated. The tool 100 includes first and second bend bodies 102, 104, and a base 105. A central channel 106 is cooperatively formed between the first and second bend bodies 102, 104 for receiving a portion of tube to be bent. The tube may be bent around the first and second bend bodies 102, 104 to impart a desired bend angle to the tubing. The bend bodies 102, 104 may respectively include first and second arcuate channels 108, 110 that extend from the central channel 106 along a curved surface of the bend bodies 102, 104. The arcuate channels 108, 110 may respectively connect to first and second straight channels 112, 114 respectively on the first and second bend bodies 102, 104. The bend bodies 102, 104 may extend from a surface of the base 105, such that the base 105 couples the first and second bend bodies 102, 104 in a fixed position relative to each other. However, it will be understood that the base 105 may have any

configuration suitable for coupling the first and second bend bodies 102, 104 together. The bend bodies 102, 104 may respectively include attachment apertures 116, 118.

[0024] The central channel 106 has a length distance A, which may be substantially the same as the length of the first and second straight channels 112, 114. The central channel 106 is adapted to secure a portion of a tube in the chamber so that the tube does not slide relative to the bending tool 100 when a portion of the tube is disposed in the central channel 106 during the bending process. During a bending process, a user may impart a bend, and then slide the tube in the central channel 106 to impart another bend on another portion of the tube. The arcuate channels 108, 110 include a curvature that extends from the central channel 106 respectively to the straight channels 112, 114. The arcuate channels 108, 110 have a curve adapted to create a bend radius to tubing. The dimensions of the arcuate channels 108, 110 may be selected based on the desired bend profile of a portion of tubing. The arcuate channels may define an arc, having a radius, wherein the radius is the bend radius. The arcuate channels 108, 110 also have a maximum bending angle, which may be understood as the angle between the central channel 106 and the respective first and second straight channels 112, 114. As illustrated, the maximum bending angle is approximately 180 degrees. However, it will be understood that a maximum bending angle may be provided that is greater or less than 180 degrees. The arcuate channels 108, 110 are open in a direction that is orthogonal to the direction of the channels 108, 110, which allows a tube to be bent to a desired angle that is less than the maximum bending angle. The arcuate channels 108, 110 may be planar, such that a tube may be bent in a single plane. However, it will be understood that the arcuate channels 108, 110 may be non-planar, and they may be adapted to bend a tube in more than one direction, such as in a helical configuration. It will also be understood that the first and second arcuate channels 108, 110 may have a different bend radius and a different maximum bending angle compared to each other.

[0025] Referring to FIGs. 3-5, the straight channels 112, 114 are shown, according to an embodiment of the present invention. The straight channels 112, 114 may each have a generally semi-circular cross-section, with an arcuate bottom surface 120 adapted to

support the tube and avoid excessive flattening or deformation of the tube (also referred to as “kinking”). The diameter of the semi-circular cross-section B may be provided according to the size of the tubing to be bent. The channels 112, 114 may also have first and second channel sides 122, 124, which support the tube and help retain the tube in position. The channel sides 122, 124 extend in a direction orthogonal to the direction in which the channels 112, 114 extend. The respective cross-sections of the arcuate channels 108, 110 include similar features to the straight channels 112, 114. The central channel 106 may also have a cross-section that includes two-semicircular portions that are spaced apart from each other at a distance that is greater than a cross-section of a tube to be bent. The semi-circular portions of the central channel 106 may have respective geometries the same as the cross-sections of the straight channels 112, 114, as shown in FIGs. 3-5. It will be understood that the central channel 106 may have other geometries that are adapted to receive a tube. The cross-sectional dimensions of the arcuate channels 108, 110 may be the same as the cross-sections of straight channels 112, 114. It will be understood that the respective lengths and cross-sections of the first and second straight channels 112, 114 may be different, and the first and second arcuate channels 108, 110 may also be different from each other. It will also be understood that additional channels may also be provided to impart different bending profiles to a tube for bending.

[0026] The bend bodies 102, 104 may respectively include attachments 116, 118. It will be understood that the attachment may be provided on one or both bend bodies 102, 104. It will also be understood that the attachments 116, 118 may be provided on the base 105, on the surface opposite of the surface of the base 105 from which the bend bodies 102, 104 extend. As shown in FIG. 1-5, attachments 116, 118 are square holes, although it will be understood that other attachment mechanisms may also be provided such as hex drive, spline drive, etc. The attachments 116, 118 may also be blind bores that have a square cross-section, or a cross-section of another shape. A drive lug of a lugged tool such as a ratchet or breaker bar tool, may be releasably coupled to one of the attachments 116, 118 to cause rotation of the bend tool 100 to impart a bend to a

portion of a tube. It will also be understood that the attachments 116, 118 may include a projection that extends from the respective bend bodies 102, 104. The attachments 116, 118 may be adapted to couple to a lugged tool, such as rachet tool 200, shown in FIG. 6A and 6B. The use of a ratchet tool allows for use of the bending tool 100 in a constrained area, so that the arm of the ratchet tool 200 can rotate the bending tool 100 to provide the desired bend to a tube. Further, drive extensions, such as drive extension 202, shown in FIG. 6B, may be coupled to the attachments 116, 118 to provide a ratchet tool 200 or other handle at a distance from the bending tool 100, so that the bending tool 100 can operate in a tight space where movement of a tool or tool handle may otherwise be obstructed.

[0027] As shown in FIG. 7, an embodiment of a bending tool 300 is shown. The bending tool 300 includes a first bend body 302 and a second bend body 304. A central channel 306 is formed between the first and second bend bodies 302, 304. The bend bodies 302, 304 may respectively include first and second arcuate channels 308, 310 that extend from the central channel 106. The bend bodies 302, 304 may also include respective third and fourth arcuate channels 309, 311 that extend from the central channel 306 in a direction away from the first and second arcuate channels 308, 310. The first and third arcuate channels 308, 309 may connect to a first straight channel 312, and the second and fourth arcuate channels 310, 311 may connect to a second straight channel 314. The respective cross-sections of the first, second, third, and fourth arcuate channels 308, 309, 310, and 311 may include the same geometry as arcuate channels 108, 110, as described above. The straight channels 312, 314 may also include the same geometry as the straight channels 112, 114, as described above.

[0028] Bending tool 300 includes a base 305, similar to the base 105 of bending tool 100. A handle 318 may be coupled to the base 305 to manipulate the bending tool 300. It will be understood that the handle 318 may also be attached at other suitable positions on the base 305 or on either of the bend bodies 302, 304.

[0029] As shown in FIGs. 8-11, another embodiment of a bending tool 400 according to the present invention is shown. The bending tool 400 is similar to the bending tool 100.

The tool 400 includes a first bend body 402 and a second bend body 404. A central channel 406 is cooperatively formed between the first and second bend bodies 402, 404. The bend bodies 402, 404 may have a substantially circular shape, and they may respectively include first and second arcuate channels 408, 410 that extend from the central channel 406. The first and second arcuate channels 408, 410 respectively extend around the bend bodies 402, 404 in a circular manner, such that the arcuate channels 408, 410 and the central channel 406 cooperatively form a full circle that surround the respective bend bodies 402, 404. The cross-sections of the first and second arcuate channels 408, 410 may include the same geometry as arcuate channels 108, 110, described above. Thus, the bend tool 400 is adapted to bend a tube at an angle greater than 180 degrees in either one of clockwise or counterclockwise directions. The bend bodies 402, 404 may also include respective first and second chamfered portions 426, 428 disposed proximal to the central channel 406, which may assist with guiding a tube into the central channel 406. The second bend body 404 includes attachment aperture 418, but it will be understood that attachments can be provided on both bend bodies 402, 404. The bend bodies 402, 404 may be coupled to a base 405, where the bend bodies 402, 404 extend from a surface of the base 405. However, it will be understood that the base 405 may have any configuration suitable for coupling the first and second bend bodies 402, 404 together.

[0030] The attachment 418 may be a square hole, although it will be understood that other attachment mechanisms may also be provided such as hex drive, spline drive, etc. The attachment 418 may also be a blind bore that has a square cross-section, or a cross-section of another shape. A drive lug of a lugged tool, such as a ratchet or breaker bar tool, may be releasably coupled to the attachment 418 to cause rotation of the bend tool 400 to impart a bend to a portion of a tube. It would also be understood that the attachment 418 may include a projection that extends from the bend body 404. The attachment 418 may be adapted to releasably couple to a lugged tool, such as rachet or breaker bar tool 200, shown in FIG. 6A and 6B. Use of a lugged tool allows the bending tool 400 to be operated in a constrained area, so that the arm of the lugged tool 200 can

cause rotation of the bending tool 400 to provide the desired bend to a tube. Further, lugged extensions 202, such as drive extension, shown in FIG. 6B, may be releasably coupled to the attachment 418 to provide a lugged tool 200 or other handle at a distance from the bending tool 400, so that the bending tool 400 can operate in a spaces where movement of a tool or tool handle may otherwise be obstructed.

[0031] As used herein, the term “coupled” and its functional equivalents are not intended to necessarily be limited to direct, mechanical coupling of two or more components. Instead, the term “coupled”, and its functional equivalents are intended to mean any direct or indirect mechanical, electrical, or chemical connection between two or more objects, features, work pieces, and/or environmental matter. “Coupled” is also intended to mean, in some examples, one object being integral with another object. As used herein, the term “a” or “one” may include one or more items unless specifically stated otherwise.

[0032] The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation. While particular embodiments have been shown and described, it will be apparent to those skilled in the art that changes and modifications may be made without departing from the broader aspects of the inventors’ contribution. The actual scope of the protection sought is intended to be defined in the following claims when viewed in their proper perspective based on the prior art.

Claims

1. A bending tool, comprising:

   a first bend body;

   a second bend body adapted to couple to the first bend body in a fixed position relative to the first bend body, wherein the first and second bend bodies respectively include first and second arcuate channels; and

   a central channel cooperatively formed between the first and second bend bodies and adapted to receive a tube, wherein the first and second arcuate channels extend from the central channel.
2. The bending tool of claim 1, wherein at least one of the first and second bend bodies includes an attachment adapted to releasably couple to another tool.
3. The bending tool of claim 1, wherein the first and second bend bodies are coupled to a base.
4. The bending tool of claim 1, wherein the first and second arcuate channels each have a substantially semi-circular cross-section that is adapted to substantially match the outer cross section of a tube to be bent.
5. The bending tool of claim 1, wherein the first and second arcuate channels each include an arcuate bottom surface and channel sides that extend from the arcuate bottom surface.
6. The bending tool of claim 1, wherein the first and second bend bodies respectively include first and second straight channels, wherein the first and second straight channels respectively extend from the first and second arcuate channels.
7. The bending tool of claim 6, wherein a first angle between the central channel and the first straight channel defines a first maximum bend angle, and a second angle between the central channel and the second straight channel defines a second maximum bend angle.
8. The bending tool of claim 7, wherein the first maximum bend angle is about 180 degrees.
9. The bending tool of claim 2, wherein the attachment is a blind bore.

10. The bending tool of claim 2, wherein the attachment is an aperture.
11. The bending tool of claim 10, wherein the aperture has a substantially square shape that is adapted to releasably couple to a lugged tool.
12. A bending tool, comprising:

    a first bend body;

    a second bend body coupled to the first bend body;

    first and second arcuate channels respectively disposed on the first and second bend bodies;

    a central channel respectively formed between the first and second bend bodies;

    a base coupled to the first and second bend bodies; and

    a handle coupled to the base.
13. The bending tool of claim 12, further comprising third and fourth arcuate channels that extend from the central channel in a direction opposite of the first and second arcuate channels.
14. The bending tool of claim 13, further comprising a first straight channel extending between the first and third arcuate channels, and a second straight channel extending between the second and fourth arcuate channels.
15. A bending tool, comprising:

    a base;

    a first bend body coupled to the base;

    a second bend body coupled to the base;

    a central channel cooperatively formed between the first and second bend bodies; and

    first and second arcuate channels respectively disposed on the first and second bend bodies, wherein the first and second arcuate channels cooperatively form a circle with the central channel.
16. The bending tool of claim 15, wherein the first and second bend bodies respectively include respective first and second chamfered portions disposed proximal to the central channel.

17. The bending tool of claim 15, wherein at least one of the first and second bend bodies includes an attachment.
18. The bending tool of claim 17, wherein the attachment is a square-shaped aperture that is adapted to releasably couple to a lugged tool.
19. The bending tool of claim 15, wherein each of the first and second arcuate channels include an arcuate bottom surface and channel sides that extend from the arcuate bottom surface.

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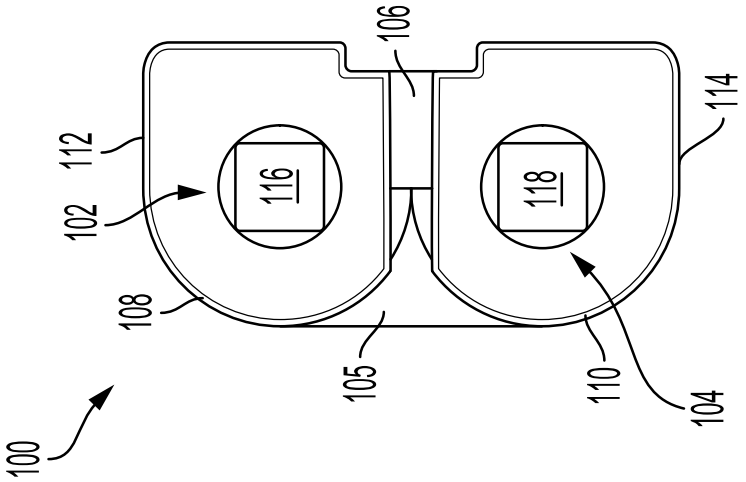

FIG. 1

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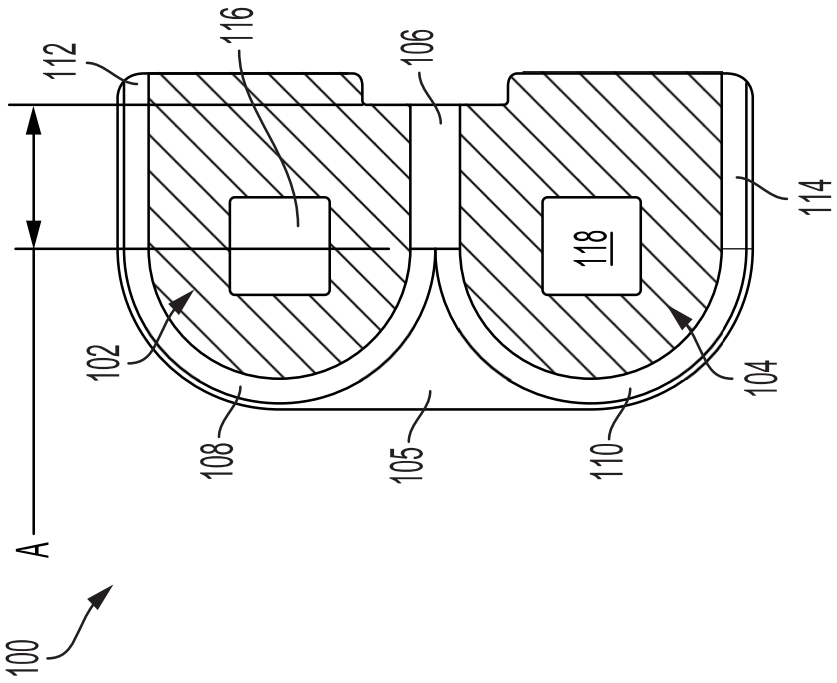

FIG. 2

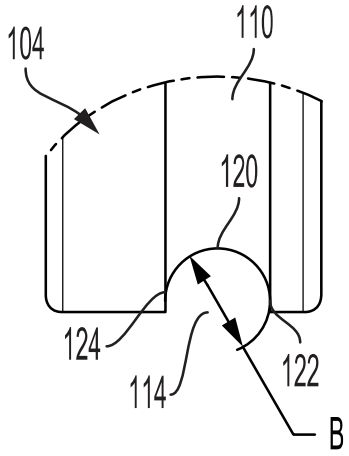

FIG. 3

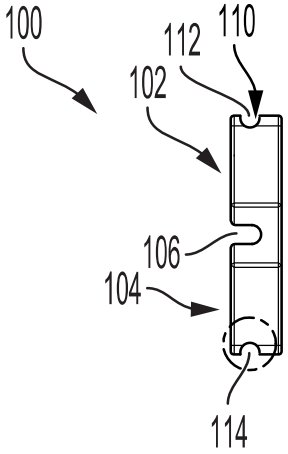

FIG. 4

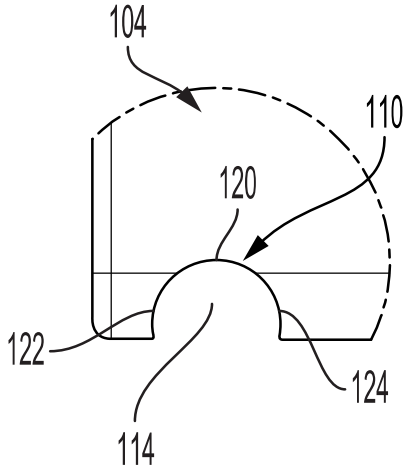

FIG. 5

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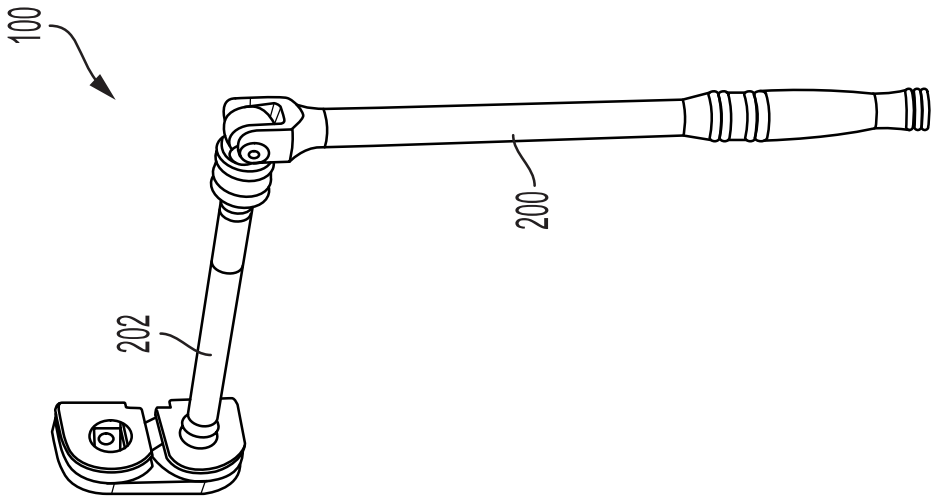

FIG. 6B

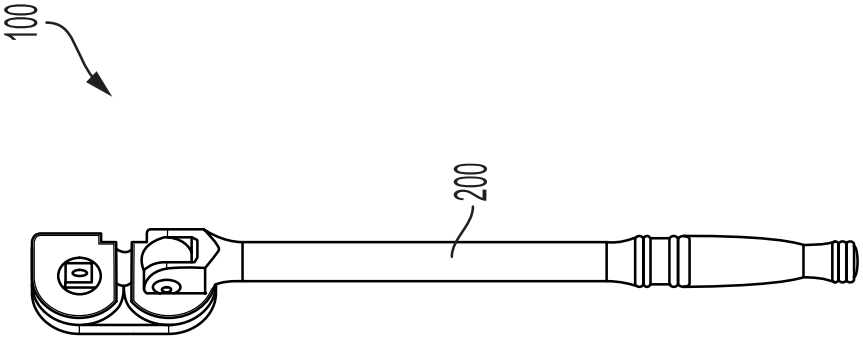

FIG. 6A

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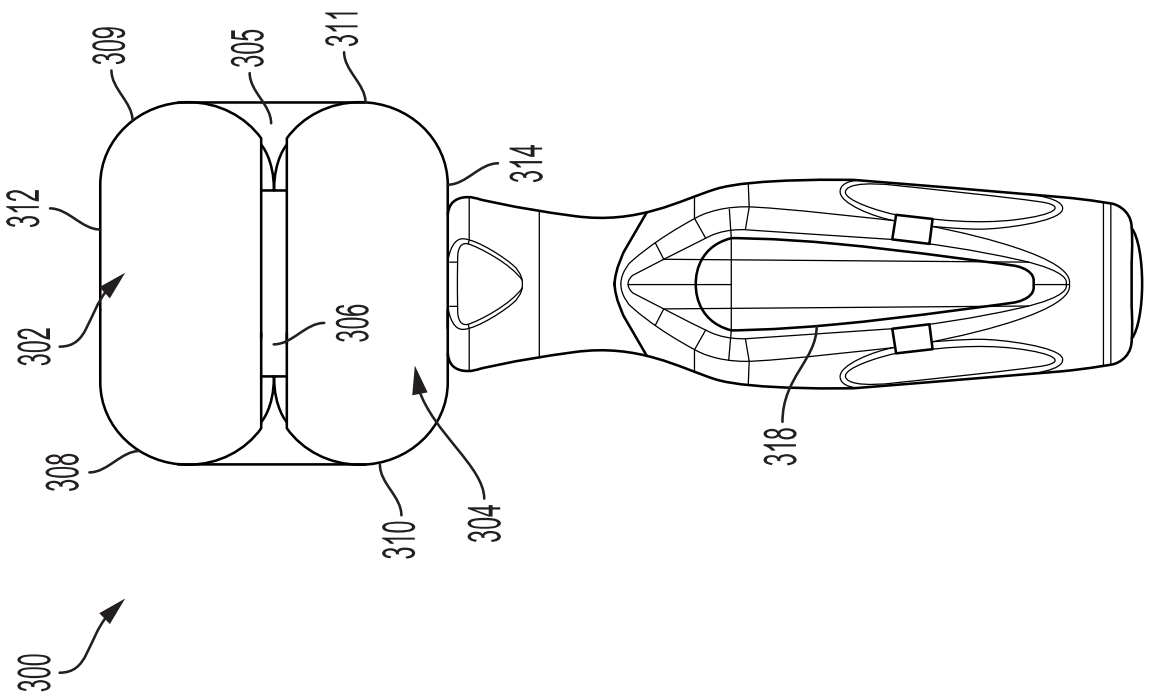

FIG. 7

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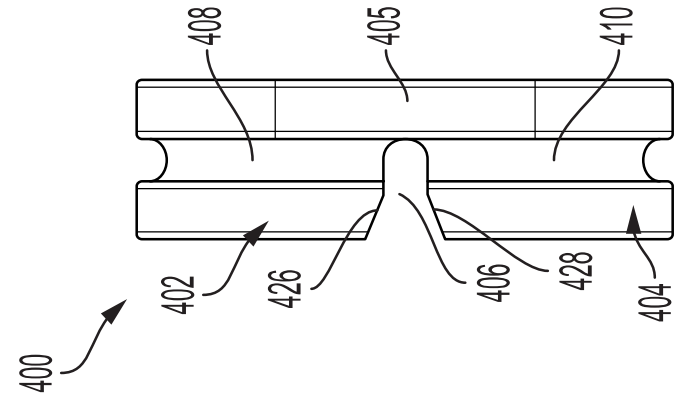

FIG. 9

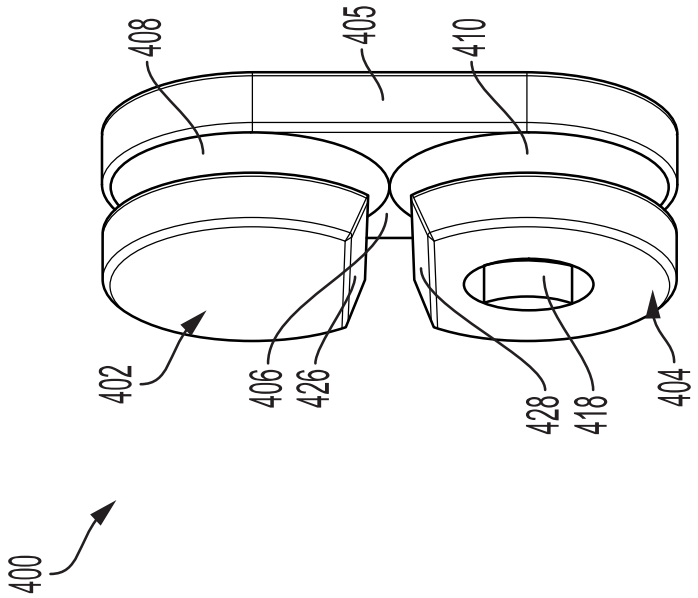

FIG. 8

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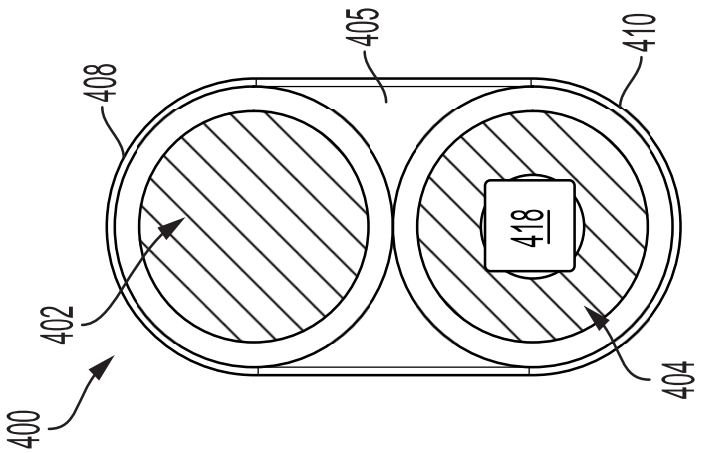

FIG. 11

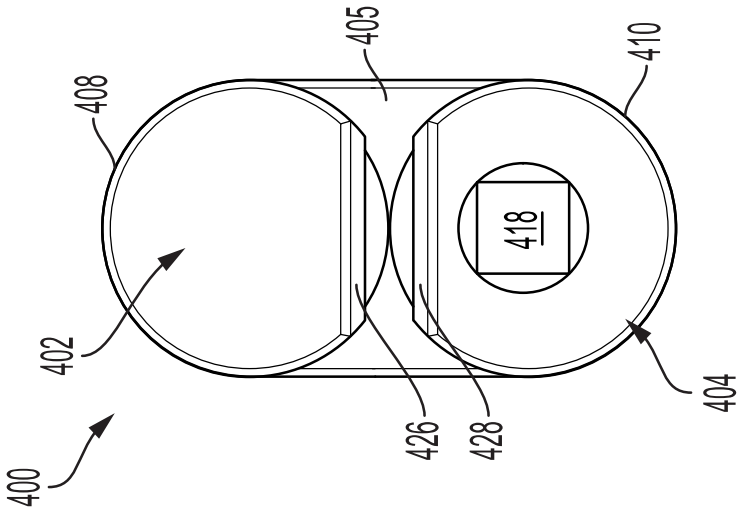

FIG. 10