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(54) **LOW FORCE TEMPORARY FASTENER**

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ÉLÉMENT DE FIXATION TEMPORAIRE À FORCE RÉDUITE

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Description

BACKGROUND INFORMATION

Field:

[0001] The present disclosure relates generally to clamping and, more particularly, the present disclosure relates to methods and apparatuses for clamping parts together with a maximum force. Still more particularly, the present disclosure relates to clamping parts, such as aircraft components, temporarily with a maximum force.

Background:

[0002] Manufacturing and assembly of structures, such as those for aircraft, may involve the assembly of different parts to form the structures. Different parts and/or structures may be connected to each other in manufacturing the aircraft. Structures such as skins, plies, reinforcing ribs, stringers, and/or other suitable structures may be used to support other parts and/or structures in the aircraft.

[0003] During the assembly of structures, it may also be desirable to temporarily join components together. For example, a skin being attached to a rib of an aircraft may be temporarily attached to the rib. During the temporary attachment, further assembly operations may take place. For example, the parts may be more permanently aligned. Additionally, permanent fastener holes may be bored or formed in the parts. As a further example, shims or spacers may be positioned between the temporarily joined parts so as to achieve a desired spacing between the parts. Other operations may also take place while two or more parts may be temporarily joined together.

[0004] A certain level of fit between parts may be desired but not always possible. For example, during manufacture of an aircraft wing assembly, the skin of a wing may be attached to a spar of the aircraft frame. The skin and spar may be examples of adjacent pieces that may benefit from the use of a shim. A shim may be placed in the space between adjacent parts. In certain cases, placement of the shim may be assisted by temporarily joining the parts together.

[0005] It may be desired to use a clamping device to temporarily join parts together. In the aviation industry, various kinds of clamps may be used. It would be desired not to harm the surfaces of the materials being assembled by using too large a clamping force. However, current clamping devices may not offer a quick means of temporarily clamping and unclamping a work piece with a force of a desired moderate force so as to assure an operator that damage to a work piece surface does not result from the clamping.

[0006] Current devices may also provide a variable clamping force which is determined by factors such as the size or thickness of a work piece. A clamp may provide a first clamping force for a work piece that is relatively thin, and the clamp may provide a second, different clamping force for a work piece that is relatively thicker. This kind of variable clamping force that depends on the size or thickness of the work piece may not be suitable for some needs.

[0007] Further clamping devices are shown in documents US 2011/088242 A1 and US 5 042 787 A.

[0008] Document EP 0 466 609 A1 shows a tool for placing insertable clamps on metal sheets to be assembled. The tool comprises a fixed cylindrical sheath interacting with the body of the clamp and a screwing sleeve accommodated in the said sheath and capable of interacting with the control nut of the displaceable mechanism of the said clamp. Moreover, the tool comprises an intermediate coupling piece capable of being linked with the said control nut and with the said screwing sleeve.

[0009] As a result, the manufacturing and assembly of an aircraft may take more time and expense than desired to obtain a desired positioning of parts during temporary clamping.

[0010] Additionally, using known methods, parts that are temporarily fastened together may be subject to too much force. Accordingly, it would be desirable to have a method and apparatus that takes into account one or more of the issues discussed above, as well as possibly other issues.

SUMMARY

[0011] Therefore, the current invention provides for a clamp according to claim 1 and a method according to claim 10.

[0012] An illustrative embodiment of the present disclosure may provide a clamp that includes a body, a fastener system, and a biasing mechanism. The body may include an interior region and a first end configured to contact a first surface of a work piece. The fastener system may be configured to move axially within the interior region of the body and through a hole in the work piece to a second surface of the work piece in which the fastener system has a second end configured to engage the second surface of the work piece. The biasing mechanism may be connected to the fastener system. The biasing mechanism may be configured to apply a force on the fastener system to cause the second end of the fastener system and the body to engage the work piece at a desired level of force at different levels of extension of the fastener system.

[0013] A further illustrative embodiment of the present disclosure may provide an apparatus for clamping a work piece at a maximum force. The apparatus may include a body, a rod, a cap, a biasing mechanism, and a pair of tangs. A first end of the body may be configured to engage a first surface of the work piece. The body may include an interior region, and the body may be characterized by an axial length. The rod may be positioned partially within the body. The rod may be configured to move along the axial length of the body and threading positioned on the

rod. The cap may be threadedly attached to the rod such that rotating the cap may cause the cap to move axially along the rod. The biasing mechanism may be connected to the rod, the body, or the cap such that axial movement of the rod beyond a desired point may engage the biasing mechanism. Rotation of the cap may compress the biasing mechanism. The biasing mechanism may be configured to establish a clamping force. The pair of tangs may be connected to the rod and may be configured to transition between an extended position and a compressed position. The tangs may be configured to engage a second surface of the work piece.

[0014] Still a further illustrative embodiment of the present disclosure may provide a method for clamping a work piece at a desired force. The method may include steps of inserting a pair of tangs through a hole of the work piece; rotating a cap connected to a rod in a first direction such that the tangs engage a surface of the work piece; and compressing a biasing mechanism to establish a clamping force.

[0015] The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives, and features thereof will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

Figure 1 is an illustration of a block diagram of an aircraft manufacturing and service method in which an illustrative embodiment may be implemented;

Figure 2 is an illustration of a block diagram of an aircraft in accordance with an illustrative embodiment;

Figure 3 is an illustration of a block diagram of a clamping environment in accordance with an illustrative embodiment;

Figure 4 is an illustration of a diagram of a clamp in use with an aircraft in accordance with an illustrative embodiment;

Figure 5 is an illustration of a diagram of a clamp in accordance with an illustrative embodiment;

Figure 6 is an illustration of a cross-sectional diagram of a clamp minus the work piece in accordance with an illustrative embodiment;

Figure 7 is an illustration of a cross-sectional diagram of a clamp in accordance with an illustrative embodiment;

Figure 8 is an illustration of a diagram of a clutch for use with a clamp in accordance with an illustrative embodiment;

Figure 9 is an illustration of a flowchart of a process for clamping a work piece in accordance with an illustrative embodiment; and

Figure 10 is an illustration of a flowchart of a process for unclamping a work piece in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

[0017] Referring more particularly to the drawings, embodiments of the disclosure may be described in the context of aircraft manufacturing and service method **100** as shown in **Figure 1** and aircraft **200** as shown in **Figure 2**. Turning first to **Figure 1**, an illustration of a block diagram of an aircraft manufacturing and service method is depicted in accordance with an illustrative embodiment. During pre-production, aircraft manufacturing and service method **100** may include specification and design **102** of aircraft **200** in **Figure 2** and material procurement **104.**

[0018] During production, component and subassembly manufacturing **106** and system integration **108** of aircraft **200** in **Figure 2** may take place. Thereafter, aircraft **200** in **Figure 2** may go through certification and delivery **110** in order to be placed in service **112**. While in service **112** by a customer, aircraft **200** in **Figure 2** may be scheduled for routine maintenance and service **114**, which may include modification, reconfiguration, refurbishment, and other maintenance or service.

[0019] Each of the processes of aircraft manufacturing and service method **100** may be performed or carried out by a system integrator, a third party, and/or an operator. In these examples, the operator may be a customer. For the purposes of this description, a system integrator may include, without limitation, any number of aircraft manufacturers and major-system subcontractors; a third party may include, without limitation, any number of vendors, subcontractors, and suppliers; and an operator may be an airline, a leasing company, a military entity, a service organization, and so on.

[0020] With reference now to **Figure 2**, an illustration of a block diagram of an aircraft is depicted in which an illustrative embodiment may be implemented. In this example, aircraft **200** may be produced by aircraft manufacturing and service method **100** in **Figure 1** and may include airframe **202** with plurality of systems **204** and interior **206**. Examples of systems **204** may include one or more of propulsion system **208**, electrical system **210**, hydraulic system **212**, and environmental system **214**. Any number of other systems may be included. Although an aerospace example is shown, different illustrative embodiments may be applied to other industries, such as the automotive industry.

[0021] Apparatuses and methods embodied herein may be employed during at least one of the stages of aircraft manufacturing and service method **100** in **Figure 1**. As used herein, the phrase "at least one of", when

used with a list of items, means that different combinations of one or more of the listed items may be used and only one of each item in the list may be needed. For example, "at least one of item A, item B, and item C" may include, for example, without limitation, item A, or item A and item B. This example also may include item A, item B, and item C or item B and item C.

[0022] In one illustrative example, components or subassemblies produced in component and subassembly manufacturing **106** in **Figure 1** may be fabricated or manufactured in a manner similar to components or subassemblies produced while aircraft **200** is in service **112** in **Figure 1**. As yet another example, a number of apparatus embodiments, method embodiments, or a combination thereof may be utilized during production stages, such as component and subassembly manufacturing **106** and system integration **108** in **Figure 1**. "A number", when referring to items, means one or more items. For example, a number of apparatus embodiments may be one or more apparatus embodiments. A number of apparatus embodiments, method embodiments, or a combination thereof may be utilized while aircraft **200** is in service **112** and/or during maintenance and service **114** in **Figure 1**. The use of a number of the different illustrative embodiments may substantially expedite the assembly of and/or reduce the cost of aircraft **200**.

[0023] For example, one or more of the different illustrative embodiments may be used to make measurements of spaces between parts during, for example, without limitation, component and subassembly manufacturing **106** and system integration **108**.

[0024] The different illustrative embodiments recognize and take into account a number of different considerations. For example, the different illustrative embodiments recognize and take into account that a certain level of fit between parts may be desired but may not always be possible. For example, during manufacture of an aircraft wing assembly, the skin of a wing may be attached to a spar of the aircraft frame. The skin and spar may be examples of adjacent pieces that may benefit from the use of a shim. A shim may be placed in the space between adjacent parts. In certain cases, placement of the shim may be assisted by temporarily joining the parts together.

[0025] The different illustrative embodiments also recognize and take into account that a clamping device may be used to temporarily join parts together. In the aviation industry, various kinds of clamps may be used. However, it may be desirable not to cause inconsistencies on the surfaces of the materials being assembled by using too large a clamping force that may result in any out of tolerance inconsistencies on the surface and/or in the structure of the materials. As used herein, an inconsistency may be an undesired change in a part. The undesired change may be on the surface, in the structure of the part, and/or some other undesired change.

[0026] However, current clamping devices may not allow for a temporary clamping with a desired level of force that avoids inconsistencies on a part. Additionally, current clamping devices may provide a variable clamping force that depends on factors such as the thickness of a work piece. Thus, the different illustrative embodiments may provide a method and apparatus for providing a clamp for use in assembling parts, such as components assembled in the manufacture of an aircraft. The clamp may be used on a temporary basis and may provide a force that has a level low enough to avoid causing inconsistencies in the parts being assembled.

[0027] An illustrative embodiment of a clamp may include a body with a channel. The body may have an interior region and exterior region and also may have a first end and a second end, with one end configured to contact a first surface of a work piece. A fastener system may be partially disposed within the channel and may be configured to move within the interior region of the body and through a hole in the work piece to a second surface of the work piece in which the fastener system may have an end configured to engage the second surface of the work piece. The clamp also may include a biasing mechanism connected to the fastener system in which the biasing mechanism may be configured to apply a force on the fastener system that may cause the second end of the fastener system and the body to engage the work piece.

[0028] With reference now to **Figure 3**, an illustration of a block diagram of a clamping environment is depicted in accordance with an illustrative embodiment. In this example, clamping environment **301** may include clamp **303** that may be used in conjunction with work piece **302**. In an illustrative embodiment illustrated in **Figure 3**, clamp **303** may be implemented to temporarily clamp work piece **302**.

[0029] Work piece **302** may take many different forms or embodiments. In one illustrative embodiment, work piece **302** may comprise aircraft **305** or a part or component of aircraft **305**. For example, work piece **302** may comprise skin **307**, plies **309**, or reinforcing structure **311**. Work piece **302** may include first surface **312** and second surface **313**, such as an upper surface and a lower surface of work piece **302.** Work piece **302** may include hole **315** which may extend through first surface **312** to second surface **313**.

[0030] As used herein, work piece **302** may include one or more components. For example, work piece **302** may include multiple layers of plies **309**. Work piece **302** may include skin **307** and reinforcing structure **311**. Reinforcing structure **311** may take the form of a structure such as a stringer, a frame, a strut, or a spar, for example, without limitation. Other combinations of components may be assembled so as to constitute work piece **302**.

[0031] Clamp **303** may include cap **320**, body **330**, rod **340**, nut engager **350**, and biasing mechanism **360**. Clamp **303** may also include clutch **370**. In one illustrative embodiment, clutch **370** may comprise a separate piece that may be attached to and removed from clamp **303**. However, other configurations of clutch **370** may be possible, such as an attached form of clutch **370**.

[0032] Body **330** may comprise a generally elongate structure. Body **330** may take the general form of a tube. In an illustrative embodiment, body **330** may be a generally cylindrical structure characterized by axial length **331**, interior region **332**, and exterior region **333**. Body **330** may take other cross-sectional forms including, for example, without limitation, rectangular, square, and triangular. Body **330** may further include first end **334** and second end **335**. Either or both of first end **334** and second end **335** may include aperture **336** providing communication between interior region **332** and exterior region **333**.

[0033] Rod **340** may comprise a moveable member partially positioned in interior region 332 of body **330** and partially positioned in exterior region **333** of body **330**. Rod **340** may include tangs **341**. In one embodiment, rod **340** may include a pair of tangs **341**. In another embodiment, rod **340** may include more than two tangs **341**. Tangs **341** may comprise teeth **342** at a distal end thereof. Teeth **342** may be ridged structures at the end of tangs **341** that allow tangs **341** to engage first surface **312** or second surface **313** of work piece **302**.

[0034] Tangs **341** may be configured to extend from rod **340** such that tangs **341** extend through aperture **336** into exterior region **333** of body **330**. Tangs **341** may be separated by slit **344** in rod **340**. Tangs **341** may include one tooth on each of tangs **341** to form teeth **342**. Tangs **341** may also be formed with a tension or bias such that at rest, tangs **341** may be in radially compressed position **345**, or in other words, tangs **341** when at rest may tend to retract inwardly toward each other.

[0035] In radially compressed position **345**, tangs **341** may be in proximity with each other such that tangs **341** may pass through hole **315** in work piece **302**. Tangs **341** may be extended to transition from radially compressed position **345** to radially extended position **346**. Tang extender **343** may be positioned within slit **344**. Tang extender **343** may assist in transitioning tangs **341** from radially compressed position **345** to radially extended position **346** and vice versa as tangs **341** move in and out of body **330**. In radially extended position **346**, tangs **341** may be extended such that teeth **342** engage first surface **312** or second surface **313** of work piece **302**. The engagement of teeth **342** with work piece **302** may allow a clamping of work piece **302**.

[0036] Rod **340** may include threads **349**. Threads **349** may be configured to engage with cap **320**. Cap **320** may include reciprocal threading **381** so as to engage threads **349** of rod **340**.

[0037] Rod **340** also may comprise nut **347**. Nut **347** may take the form of hex nut **348**; however, other shapes, such as a square also may be possible. In one illustrative embodiment, nut **347** may be fixedly attached to rod **340**. As explained further herein, hex nut **348** may be slidably held in nut receiving region **351** of body **330** such that nut **347** may slide along axial length **331** but may not be able to rotate. Because nut **347** may not be able to rotate, rod **340** may not be able to rotate.

[0038] Body **330** in its interior region **332** may further comprise nut engager **350**. Nut engager **350** may take the form of nut receiving region **351** or hex nut receiving region **352**. Nut receiving region **351** may be configured to receive nut **347**. When nut **347** takes the form of hex nut **348**, hex nut receiving region **352** may be configured with a hexagonal shape to receive hex nut **348**. Nut receiving region **351** may contact nut **347** so as to substantially prevent nut **347** from rotating within interior region **332** of body **330**. However, nut receiving region **351** may have length **353** so that nut **347** may be free to move along axial length **331** of body **330**. Nut engager **350** also may include first stop **391** and second stop **392**. First stop **391** and second stop **392** may set limits to the travel of nut **347** within nut receiving region **351**. Thus, the distance between first stop **391** and second stop **392** also may set a limit to the degree of axial travel allowed to rod **340**.

[0039] Other configurations in addition to nut **347** and nut engager **350** may also be used to allow axial travel of rod **340** while also preventing rotation of rod **340**. For example, rod **340** may include a pin that slides within a raceway of body **330**. The pin may be allowed to travel between first stop **391** and second stop **392**.

[0040] Biasing mechanism **360** may be positioned within interior region **332** of body **330**. Biasing mechanism **360** may comprise spring **361**, such as a coiled spring. Biasing mechanism **360** may surround rod **340**. Biasing mechanism **360** may be held between rest **383** positioned on body **330** and also against seat **384** of cap **320**. Additionally, a washer or plurality of washers may be used in conjunction with rest **383** and seat **384** so as to hold biasing mechanism **360** in the desired position. In this manner, biasing mechanism **360** may exert a force against rod **340** as rod **340** moves along axial length **331** of body **330.**

[0041] Cap **320** may also be connected to rod **340**. Cap **320** may extend through aperture **336** in second end **335** of body **330** such that cap **320** extends to exterior region **333** of body **330**. Cap **320** may be connected to rod **340** through engagement with threads **349** on rod **340**. Cap **320** may include flange **359** that rotatably holds cap **320** in body **330** and prevents cap **320** from disconnecting from body **330**. Further, cap **320** may have a diameter and exterior surface configured to receive clutch **370**.

[0042] Cap **320** and rod **340** may be threadedly connected such that a rotation of cap 320 in a desired rotational direction may move cap **320** along axial length **331** of rod **340** onto rod **340**. When clamp **303** engages work piece **302**, first end **334** of body **330** may contact first surface **312**, and teeth **342** of tangs **341** may contact second surface **313** of work piece **302**. In such a position, rod **340** may be prevented from axial movement **355** relative to body **330**. Continued rotation of cap **320**, which may tend to move rod **340** in that axial direction, instead may cause cap **320** to advance onto the threaded connection with rod **340**. The rotation thus may cause an

advancement that draws cap **320** through aperture **336** and into interior region **332** of body **330**. While cap **320** is rotated and advances axially along rod **340**, biasing mechanism **360** may also be compressed. Thus, continued rotation of cap **320** may cause a force from biasing mechanism **360** to develop. This force may act as a clamping force of clamp **303**.

[0043] Clutch **370** may be reversibly attached to cap **320.** Clutch **370** may, therefore, comprise reversible clutch **371**. Clutch **370** may be attached to cap **320** in first position **372** such that clutch **370** may only rotate in one direction, such as a clockwise direction. Clutch **370** may then be removed from cap **320**, reversed, and attached in second position **373**. In second position **373**, clutch **370** may only rotate cap **320** in a second direction, such as counterclockwise. In this manner, clutch **370** may be configured to removably attach to cap **320**. A commercial example of clutch **370** that may be used with clamp **303** is offered by Monogram Aerospace Fasteners of Los Angeles, California.

[0044] The operation of clutch **370** with cap **320** and rod **340** may further be characterized by a limited amount of travel **357** permitted to cap **320**. As clutch **370** rotates cap **320**, cap **320** may advance along rod **340**. Clutch **370**, however, may be in contact with second end **335** of body **330** and may be prevented from advancing with cap **320**. Continued rotation of clutch **370** may continue to rotate cap **320** and thus tend to pull cap **320** out of clutch **370**.

[0045] Depending on the rotation, clockwise or counterclockwise, cap **320** may tend to move into body **330** or out of body **330**. As cap **320** continues to move into body **330**, clutch **370** may eventually disengage from cap **320** after a sufficient length of travel **357**. This length of travel **357** also may represent one limit to the compression of biasing mechanism **360**. The maximum force of biasing mechanism **360** may also be limited by the total possible compression length of biasing mechanism **360**. In one embodiment, without limitation, the maximum force may be about 10 pounds of force or another amount of force. In another example, with appropriate biasing mechanism **360**, the maximum force may be set to about 15 pounds, about 20 pounds, about 25 pounds, about 30 pounds, or any other different higher or lower amount of force. This maximum force, which may also be referred to as the clamping force, may also be a predetermined or desired level of force.

[0046] Clutch **370** may include rollers **377** configured to engage with cap **320**. Rollers **377** may be configured such that rotation of clutch **370** imparts a rotation on cap **320** through the engagement of rollers **377** with cap **320**. As cap **320** moves relative to clutch **370**, rollers **377** may begin to disengage from cap **320**. At a distance of disengagement, rollers **377** may disengage from cap **320** such that the rotation of clutch **370** no longer rotates cap **320**. Thus, the length of rollers **377** may determine the travel of cap **320** before clutch **370** disengages from cap **320**, and thus the length of rollers **377** also may determine a clamping force applied by clamp **303**.

[0047] As stated, clutch **370** may be attached in first position **372**, reversed, and then attached in second position **373**. Rollers **377** may be configured so as to rotate cap **320** in each of first position **372** and second position **373**. Further, rollers **377** may be configured as ratcheting rollers such that rollers **377** only impart rotation to cap **320** in a single rotational direction in each of first position **372** and second position **373**.

[0048] The effect of clutch **370** may be to determine a level of force for clamping work piece **302** regardless of the thickness of work piece **302** and regardless of how far tangs **341** extend through work piece **302**. Provided that clamp **303** is properly sized for work piece **302** such that tangs **341** may pass through work piece **302** and such that teeth **342** of tangs **341** may engage with second surface **313** of work piece **302**, clutch **370** may operate so as to set up a desired level of clamping force. Because clutch **370** may disengage from cap **320** after cap **320** has traveled a desired distance into body **330**, that amount of travel **357** also may define the maximum force for clamp **303**. The maximum amount of travel for cap **320** that is allowed by clutch **370** also may impart a maximum compression of biasing mechanism **360**.

[0049] The maximum force may not be dependent on either the thickness of work piece **302** or how far tangs **341** have extended so as to engage work piece **302**. At different levels of extension of tangs **341** into work piece **302**, clamp **303** may set up a maximum clamping force. Regardless of the thickness of work piece **302** and regardless of how far tangs **341** have extended to engage work piece **302**, it may be the linear travel of cap **320** that imparts the clamping force. Further, regardless of the thickness of work piece **302** or the extension of tangs **341**, cap **320** may be set to a maximum extension from body **330** by rotating cap **320** in the direction that causes cap **320** to extend from body **330.** Flange **359** of cap **320** may contact body **330**, stopping the extension of cap **320** at a point of maximum extension from body **330**. From the point of maximum extension, cap **320** may then be rotated so as to enter into body **330** and so as to set up the clamping force. As described, it may then be the rotation of clutch **370** that determines the maximum travel of cap **320** along axial length **331** and thus the maximum clamping force.

[0050] In a further embodiment, body **330** may be configured with first closure **395** and second closure **396**. First closure **395** may attach to first end **334** of body **330**, and second closure **396** may attach to second end **335** of body **330**. First closure **395** and second closure **396** may be attached by any means, such as, for example, threading. First closure **395** and second closure **396** may be removed so as to allow access to interior region **332** and components of clamp **303**. If, for example, it is desired to change biasing mechanism **360** or rod **340**, first closure **395** and second closure **396** may be removed. Thus, different kinds of forces may be allowed by using biasing mechanism **360** with a desired force.

[0051] Additionally, different lengths of rod **340** may be used depending on, for example, the thickness of work piece **302**. Rod **340** having tangs **341** that are lengthy may be used with a thicker work piece **302**. Rod **340** having tangs **341** that are shorter may be used with a thinner work piece **302**. In this manner, multiple rods **340** of different overall lengths may be used with one body **330**.

[0052] Positioner **397** may be positioned in interior region **332**. Positioner **397** may take the form of a spring, such as a coiled spring, although other types of biasing devices may be possible for positioner **397**. Positioner **397** may tend to press against rod **340** and to hold rod **340** against second stop **392**. Positioner **397** may have a weaker force value than biasing mechanism **360**.

[0053] Clamp **303** may also be configured so that an operator may manually manipulate cap **320** so as to cause a partial movement of rod **340**. The movement of rod **340** may cause a movement of tangs **341**. For example, when clamp **303** is not engaged in clamping work piece **302**, an operator may press on cap **320**. The overall design of clamp **303** may allow an operator to grasp body **330** with his hand while pressing on cap **320** with his thumb. Pressing on cap **320** also may act to push on rod **340** because of the threaded connection between cap **320** and rod **340**. Cap **320** may be allowed to move as seat **384**, which may be attached to cap **320**, and may be allowed for movement within interior region **332**. However, the movement of rod **340** and cap **320** may be resisted by positioner **397**. Positioner **397** may thus be selected with a sufficiently low force such that the thumb force of an operator may overcome the force positioner **397** exerts on rod **340**. In this manner, a user may adjust the extension of tangs **341** so as to bring teeth **342** into contact with second surface **313** of work piece **302** prior to the compression of biasing mechanism **360**. Once contact is made between teeth **342** and second surface **313** of work piece **302**, biasing mechanism **360** may be further compressed as described above with rotation of clutch **370**.

[0054] The illustration of clamping environment **301** in **Figure 3** is not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. Other components in addition to and/or in place of the ones illustrated may be used. Some components may be unnecessary. Also, the blocks may be presented to illustrate some functional components. One or more of these blocks may be combined, divided, or combined and divided into different blocks when implemented in an illustrative embodiment.

[0055] In an illustrative embodiment of the disclosure, the configuration of the clamp may include a body, a rod, a cap, a biasing mechanism, and a pair of tangs. A first end of the body may be configured to engage a first surface of the work piece. The body may include an interior region, and the body may be characterized by an axial length. The rod may be positioned partially within the body. The rod may be configured to move along the axial length of the body and threading positioned on the rod. The cap may be threadedly attached to the rod such that rotating the cap may cause the cap to move axially along the body. The biasing mechanism may be connected to the rod, the body, or the cap such that axial movement of the rod beyond a desired point may engage the biasing mechanism. Rotation of the cap may be configured to compress the biasing mechanism. The biasing mechanism may be configured to establish a clamping force. The pair of tangs may be connected to the rod and may be configured to transition between an extended position and a compressed position. The tangs may be configured to engage a second surface of the work piece.

[0056] In a further illustrative embodiment of the disclosure, a clamp may include a spring positioned in an interior region of a body. A first end of the spring may rest against a rest and a second end of the spring may rest against a seat of a cap. As the cap may be rotated in a first direction, it may tend to compress the spring, and as the cap may be rotated in a second direction, it may tend to decompress the spring. Compression of the spring may transfer to a rod of the clamp as a clamping force.

[0057] In a further illustrative embodiment, a clamp may include a rod. A nut may be attached to the rod, and the nut may travel axially in a nut receiving region in an interior region of the clamp. The nut receiving region may have a first stop and a second stop which may act as limits to axial travel of the nut. The limit of travel of the nut also may set a limit of travel for the rod.

[0058] In a further illustrative embodiment, a clamp may include a positioner, such as a spring. The positioner may tend to push against a rod of the clamp so as to keep the tangs connected to the rod in a retracted position.

[0059] With reference now to **Figure 4**, an illustration of an aircraft on which a clamp may be used is depicted in accordance with an illustrative embodiment. In this illustrative example, a diagram of clamps **465**, **466**, **467**, and **468** may be depicted in accordance with an illustrative embodiment. Clamps **465**, **466**, **467**, and **468** may be shown as engaged with parts on aircraft **405**. Clamps **465**, **466**, **467**, **and 468** may not necessarily be drawn to scale with respect to aircraft **405**. Clamps **465**, **466**, **467**, and **468** may be implemented using clamp **303** in **Figure 3**. In this example, clamps **465**, **466**, **467,** and **468** may be examples of a physical implementation of clamp **303** shown in block form in **Figure 3**.

[0060] In this illustrative example, clamps **465**, **466**, **467**, and **468** may be used in conjunction with aircraft **405**. Aircraft **405** may be an example of one physical implementation of aircraft **200** in **Figure 2**. Aircraft **405** may include wing **406**. Wing **406** may include skin **407** and struts **411**. Struts **411** may be shown in dashed lines to illustrate that struts **411** may be positioned below skin **407**. Skin **407** and struts **411**, in this example, may illustrate one example of work piece **302** in **Figure 3**. The plurality of clamps **465**, **466**, **467**, and **468** may be posi-

tioned as shown so as to temporarily clamp skin **407** to struts **411**. Further, clamps **465**, **466**, **467**, and **468** may temporarily clamp skin **407** and struts **411** with a maximum amount of force. While temporarily clamped together, other work operations may take place with respect to skin **407** and struts **411**, such as, for example, shimming and boring.

[0061] **Figure 4** may represent one illustrative embodiment of an application of clamp **465**. A clamp, such as clamp **465**, may also be used in other usages and applications. For example, clamp **465** may also be used to clamp multiple plies in a layup of composite materials. The relatively low force of clamp **465** may provide adequate clamping force for usage with composite materials so as to clamp plies together, but also desirably may avoid excessive force that may cause out of specification inconsistencies on a surface of composite materials. A clamp, such as clamp **465**, may also be used to clamp a composite skin to a support structure prior to installing permanent fasteners. Many other usages and applications of a clamp, such as clamp **465**, may also be achieved.

[0062] With reference now to **Figure 5**, an illustration of a diagram of a clamp is depicted in accordance with an illustrative embodiment. In this example, clamp **503** may be an example of a physical implementation of clamp **303** shown in block form in **Figure 3**. Additionally, clamp **503** may be an example of clamps **465**, **466**, **467**, and **468** in **Figure 4**.

[0063] In this illustrative example, clamp **503** may be used in conjunction with work piece **502**. Work piece **502** may include first ply **509** and second ply **509a**. Cap **520** may be shown extending from second end **535** of body **530**. Pair of tangs **541** may be shown extending below work piece **502**. Tangs **541** may include a pair of teeth **542**. First end **534** of body **530** may be depicted in contact with first surface **512** of work piece **502**. Although not depicted in **Figure 5**, tangs **541** may be drawn into the interior region of body **530** so as to draw pair of teeth **542** into contact with second surface **513** of work piece **502**, thereby completing the clamping of work piece **502**.

[0064] Still referring to **Figure 5**, movement of components of clamp **503** also may be illustrated. Cap **520** may be configured to rotate in a first direction as shown in arrow **566**. It is noted that cap **520** may also be rotated in the opposite direction. Described in other words, cap **520** may be configured so as to rotate both clockwise and counterclockwise.

[0065] Rotation of cap **520** also may act to move cap **520** in axial directions shown by arrow **567**. It is noted that cap **520** may move in a generally upward or downward direction, relative to surface **512**. Rotation of cap **520** in the direction of arrow **566** may tend to move cap **520** in one of axial directions of arrow **567**, depending on the cut of threads **349** as depicted in **Figure 3**. Rotation of cap **520** in the opposite direction of arrow **566** may tend to move cap **520** in the opposite one of axial directions of arrow **567**. The movement of cap **520** in axial directions of arrow **567** also may move cap **520** into body **530** or out of body **530**. Thus, depending on the direction and amount of rotation that cap **520** receives, cap **520** may extend fully or less than fully from body **530.**

[0066] Turning now to **Figure 6**, an illustration of a cross-sectional diagram of a clamp minus the work piece as illustrated in **Figure 5** is depicted in accordance with an illustrative embodiment. **Figure 6** may be an illustration of a cross-sectional diagram following cross-sectional lines **6-6** of **Figure 5**. In this view, clamp **603** may be depicted with tangs **641** in radially compressed position 645. Tangs 641 may be in a relaxed state, meaning that tangs 641 may be in proximity and present a narrow profile. Thus, tangs 641 may be introduced into a hole of a work piece in this configuration. It is noted that cap 620 may be rotated. Further, the rotation may take place using a clutch (not shown). Rotation of cap 620 may act to advance cap 620 along rod 640. Advancement of cap 620 relative to rod 640 may compress biasing mechanism **660** thereby providing a clamping force on tangs **641**. It is noted that rod **640** and biasing mechanism **660** may be positioned within the channel or interior region **632** of body **630**.

[0067] **Figure 6** also may show various features of clamp **603**. Features may include first end **634** and second end **635**, aperture **636**, and nut **647**. Nut **647** may be shown traveling in nut receiving region **651**. Further, nut **647** may be shown as running between first stop **691** and second stop **692**. Biasing mechanism **660** may include spring **661**. Spring **661** may contact rest **683** and seat **684**. Seat **684**, which may be attached to cap **620**, may have a freedom to travel within interior region **632** along axial length **631**. Rod **640** and tangs **641** may be shown as extending along axial length **631** of body **630**. Tangs **641** may also be shown as including slit **644** and teeth **642**. Tangs **641** may be positioned about tang extender **643**. Threads **649** may be shown on rod **640**. Positioner **697** may be disposed within body **630** and may be configured to press against rod **640**. Positioner **697** may take the form of a spring and may be positioned around tangs **641**.

[0068] Referring still to **Figure 6**, the physical dimensions of clamp **603** may vary. In an illustrative embodiment, body **630** of clamp **603** may comprise a generally cylindrical shape. Tangs **641** may extend out of body **630**. Cap **620** also may extend out of body **630**. Cap **620** may take different lengths in different embodiments. In one illustrative embodiment, cap **620** may extend out of body **630** even when tangs **641** are at maximum extension from body **630**. The length of body **630** may be shown by reference number **617**. For example, without limitation, length **617** of body **630** may be between about 4 inches to about 5 inches or another length. The diameter of body **630** may be indicated by reference number **619**. For example, without limitation, diameter **619** of body **630** may be between about 0.625 inches to about 1.25 inches. Alternatively, diameter **619** of body **630** may be of any other size.

[0069] With respect to the clamping force exerted by clamp **603**, the force also may vary but may be applied to a maximum force. For example, without limitation, in the illustrative embodiment, where clamp **603** may be used to temporarily clamp skin **407** and struts **411** in **Figure 4**, the clamping force may be set not to exceed about 10 pounds of force or another appropriate amount of force. As further explained herein, the maximum clamping force may be achieved by fully rotating cap 620 so as to impart the maximum axial movement of cap 620 allowed by the clutch. A lesser amount of rotation and axial movement of cap 620 may impart a lesser force.

[0070] Cap 620 may be placed in a position of maximum extension from body 630 by rotating cap 620 in the direction that causes cap 620 to extend from body 630. Cap 620 may be so moved until flange **685** attached to cap **620** contacts body **630** and is stopped from further axial movement. At the point of maximum extension, the clutch may be attached and may rotate cap **620** such that cap **620** moves back into body **630**. The clutch may rotate cap **620** until the clutch disengages. The amount of axial movement imparted onto cap **620** also may cause a linear compression of spring **661**. The linear compression of spring **661** may set up the clamping force. It may be a maximum clamping force because the maximum linear compression of spring **661** may be established by the maximum axial movement allowed to cap **620**.

[0071] Further, the maximum clamping force may be applied regardless of the thickness of the work piece. Once teeth **642** have been brought into contact with a surface of the work piece and first end **634** of body **630** is likewise in contact with an opposing surface of the work piece, rod **640** may be restricted from any significant axial movement that may tend to compress the work piece. However, regardless of the thickness of the work piece, or in other words, regardless of how far rod **640** has been extended so as to make contact with the work piece, cap **620** may be extended to its maximum extension from body **630**. From that position of maximum extension, cap **620** may be rotated so as to apply the clamping force. Thus, the constant or maximum clamping force may be applied regardless of the thickness of the work piece.

[0072] Turning now to **Figure 7**, an illustration of a cross-sectional diagram of a clamp as illustrated in **Figure 5** is depicted in accordance with an illustrative embodiment. **Figure 7**, like **Figure 6**, may be an illustration of a cross-sectional diagram following cross-sectional lines **6-6** of **Figure 5**. **Figure 7** may illustrate the same features as **Figure 6** and thus the same reference numbers may be used in **Figure 7** as were used in **Figure 6**. In **Figure 7**, clamp **603** may be depicted with tangs **641** in axially retracted and radially extended position **700**. Tangs **641** may be moved, as rod **640** may move, such that tangs **641** may be pulled over tang extender **643**. Tang extender **643** may be positioned in slit **644** and here may act to expand tangs **641** in the radial directions indicated by arrows **702** and **704**. Thus, tangs **641** now may define a spatial relationship such that pair of tangs **641** may not be pulled through a hole in a work piece. Rather, teeth **642** may engage a surface of the work piece. As biasing mechanism **660** is further tightened, by rotating cap **620**, a force may be established between teeth **642,** tangs **641**, and first end 634 of body 630. The force that is established may be a maximum force that may depend on the compressed length of spring 661.

[0073] Turning now to Figure 8, an illustration of a diagram of a clutch for use with a clamp is depicted in accordance with an illustrative embodiment. In this example, clutch 870 may be an example of a physical implementation of clutch 370 shown in block form in Figure 3. Clutch **870** may define cap receiving region **875**. Cap receiving region **875** may be configured to engage cap **620** as shown in **Figure 6.** Cap receiving region **875**, when engaged with cap **620**, may translate a rotation of clutch **870** into a rotation of cap **620**. Clutch **870** may further define grip **877** by which an operator or worker may manually grasp clutch **870**. Clutch **870** may be reversible and may attach to cap **620** in either first position **872** or second position **873**. First position **872** may be achieved by attaching clutch **870** with a first side placed downward onto cap **620**, and second position **873** may be achieved by reversing clutch **870**. Clutch **870** may include rollers **879** or other mechanisms to impart rotation onto cap **620**.

[0074] As described with respect to **Figure 3**, clutch **870** may be configured so as to engage and then disengage from cap **620**. When cap **620** is positioned so as to extend a sufficient length from second end **635** of body **630**, cap **620** may be engage with cap receiving region **875** of clutch **870**. The length of extension of cap **620** from body **630** may be achieved by rotating cap **620** in the direction of rotation that causes cap **620** to extend. If desired to move cap **620** to its maximum extension, cap **620** may be rotated until flange **685** contacts body **630**. As clutch **870** is rotated, cap **620** may rotate and advance into interior region **632** of body **630**. Cap **620** may advance a sufficient amount until it disengages from clutch **870** and clutch **870** may no longer grasp cap **620**.

[0075] While clutch **870** in **Figure 8** may be depicted as substantially cylindrical in shape and manually operated, clutch **870** may take other shapes and embodiments and may be operated in a different manner. For example, without limitation, clutch **870** may be adapted to receive a powered form of operation. In this manner, clutch **870** may be adapted to receive a driver, a drill, an electric motor, or another form of device that imparts powered rotation on clutch **870**. Additionally, clutch **870** may be adapted to receive a wrench, a ratchet wrench, or another form of manual device that applies rotation. As for its shape, clutch **870** may take other forms, such as, for example, without limitation, angled, square, and hexagonal.

[0076] With reference now to **Figure 9**, an illustration of a flowchart of a process for clamping is depicted in accordance with an illustrative embodiment. The process may be generally designated by reference number **900**

and may be a process for temporarily clamping a work piece including a first part and a second part. One example of the process may be temporarily clamping a work piece comprising a skin and a strut in an aircraft as depicted in **Figure 5**. The method may be implemented, for example, using clamp **603** in **Figure 6** and **Figure 7** interacting with work piece **302** of **Figure 3**, and the following reference numbers may track the structures and features of those figures.

[0077] Process **900** may begin by inserting pair of tangs **641** into work piece **302** (operation **901**). Tangs **641** may be positioned in radially compressed position **645**, that is to say their natural or relaxed position. In this position, tangs **641** may be sufficiently close together so that tangs **641** may pass through hole **315** in work piece **302**.

[0078] In a further step, clutch **370** may be attached to cap **620** (operation **902**). Cap **620** may extend a sufficient distance beyond second end **635** of body **630** such that clutch **370** may be engaged with cap **620**. Further, clutch **370** may engage cap **620** in one of two reversible positions such that rotation of clutch **370**, and thereby rotation of cap **620**, may act to advance cap **620** along the length of rod **640** such that cap **620** may move into interior region **632** of body **630**.

[0079] In a further step, cap **620** may be rotated (operation **903**). Rotation of cap **620** may occur by the rotation of clutch **370**. Rotation of cap **620** may cause cap **620** to advance along threads **649** of rod **640**. Rod **640** eventually may reach a point where its axial movement is no longer possible. This may be because tangs **641** have made contact with first surface **312** of work piece **302**. Also, further axial movement of rod **640** may be prevented if teeth **642** on tangs **641** contact with first end **634** of body **630**. Once movement of rod **340** along axial length **631** of body **630** is prevented, the further rotation of cap **620** may cause cap **620** to advance along rod **640** and move into interior region **632** of body **630**.

[0080] In a further step, tangs **641** may be expanded (operation **904**). Tangs **641** may be positioned around tang extender **643**. Movement of tangs **641** may draw tang extender **643** through slit **644** in tangs **641** such that pair of tangs **641** may transition from radially compressed position **645** to radially extended position **700**. In radially extended position **700**, tangs **641** may have become wider and may not move through hole **315** of work piece **302**.

[0081] In a further step, tangs **641** may engage with first surface **312** of work piece **302** (operation **905**). Rod **640** and tangs **641** may be moved until tangs **641** make contact with first surface **312** of work piece **302**. The contact may include pair of teeth **642** making contact with first surface **312**.

[0082] In a further step, body **630** of clamp **603** may contact second surface **313** of work piece **302** (operation **906**). More particularly, first end **634** of body **630** may contact second surface **313** of work piece **302**. First end **634** may comprise a substantially flat surface so as to make a stable and substantial contact with second surface **313**.

[0083] In a further step, cap **620** may continue to rotate until clutch **370** disengages from cap **620** (operation **907**). Cap **620** may continue to move into interior region **632** of body **630** until clutch **370** may no longer engage with cap **620**. At this point, cap **620** may no longer be rotated. Cap **620** may no longer compress biasing mechanism **660**. The force established at this point may be the maximum clamping force for clamp **603**.

[0084] Because clutch **370** may disengage from cap **620** after cap **620** has traveled a desired distance into body **630**, that amount of travel also may define the maximum force for clamp **603**. The maximum force may not be dependent on either the thickness of work piece **302** or how far tangs **641** may have extended so as to engage work piece **302**. At different levels of extension of tangs **641** into work piece **302**, clamp **603** may set up a maximum clamping force.

[0085] With reference now to **Figure 10**, an illustration of a flowchart of a process for unclamping a work piece is depicted in accordance with an illustrative embodiment. The process may be generally designated by reference number **1000** and may be a process for unclamping a work piece including a first part and a second part. One example of the process may be unclamping a skin and a strut in an aircraft as depicted in **Figure 5** that have been subjected to clamping. The method may be implemented, for example, using clamp **603** in **Figure 6** and **Figure 7** interacting with work piece **302** of **Figure 3**, and the following reference numbers may track the structures and features of those figures.

[0086] Process **1000** may begin by attaching clutch **370** in reverse position on cap **620** (operation **1001**). The reverse position may be the opposite position as compared to the manner in which clutch **370** was attached to cap **620** for clamping. For example, if clutch **370** had been attached in first position **372** for clamping, it may be attached in second position **373** for unclamping.

[0087] In a further step, clutch **370** may be rotated (operation **1002**). This rotation may act to rotate cap **620**, which may move cap **620** outwardly along rod **640** so as to move cap **620** into exterior region **333** of body **630**.

[0088] In a further step, rod **640** may be extended (operation **1003**). As cap **620** may be moved outwardly into exterior region **333**, the compression set up on biasing mechanism **660** may be relaxed. Biasing mechanism **660** thus may tend to push against rod **640** so as to move tangs **641** away from contact with first surface **312** of work piece **302**. Biasing mechanism **660** may act against rod **640** by pushing on rest **683** and seat **684**.

[0089] In a further operation, tangs **641** may be compressed (operation **1004**). As tangs **641** extend and move away from first surface **312**, tangs **641** also may move away from tang extender **643**. The tips of tangs **641**, where pair of teeth **642** may be located, may move into their natural position, radially compressed position **645**.

[0090] In a further operation, tangs **641** may be withdrawn through work piece **302** (operation **1005**). Tangs

641, when in radially compressed position **645**, may present a profile that is narrower than hole **315** of work piece **302**. Tangs **641** may be withdrawn through hole **315**. At this point, the clamping may be completed. Further work on work piece **302** or aircraft **305** may proceed as needed.

[0091] The flowcharts and block diagrams in the different depicted embodiments illustrate the architecture, functionality, and operation of some possible implementations of apparatuses and methods in an illustrative embodiment. In this regard, each block in the flowcharts or block diagrams may represent a module, segment, function, and/or a portion of an operation or step.

[0092] In some alternative implementations of an illustrative embodiment, the function or functions noted in the blocks may occur out of the order noted in the figures. For example, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be performed in the reverse order, depending upon the functionality involved. Also, other blocks may be added in addition to the illustrated blocks in a flowchart or block diagram.

[0093] In an illustrative embodiment of the disclosure described herein, a method and apparatus for providing a temporary, low force clamp for use in assembling parts, such as components assembled in the manufacture of an aircraft, may be described. An illustrative embodiment of a clamp may include a body with a channel. The body may have an interior region and exterior region and also may have a first end and a second end, with one end configured to contact a first surface of a work piece. A fastener system may be partially disposed within the channel and may be configured to move within the interior region of the body and through a hole in the work piece to a second surface of the work piece. The fastener system may have an end configured to engage the second surface of the work piece. The clamp also may include a biasing mechanism connected to the fastener system in which the biasing mechanism may be configured to apply a force on the fastener system so as to cause the second end of the fastener system and the body to engage the work piece. In one illustrative embodiment, the biasing mechanism and fastener system may allow a clamping force of up to about 10 pounds force.

[0094] In an illustrative embodiment of the disclosure, the configuration of the clamp may include a body, a rod, a cap, a biasing mechanism, and a pair of tangs. A first end of the body may be configured to engage a first surface of the work piece. The body may include an interior region, and the body may be characterized by an axial length. The rod may be positioned partially within the body. The rod may be configured to move along the axial length of the body and threading positioned on the rod. The cap may be threadedly attached to the rod such that rotating the cap may cause the cap to move axially along the rod. The biasing mechanism may be connected to the rod, the body, or the cap such that axial movement of the rod beyond a desired point may engage the biasing mechanism. Rotation of the cap may be configured to compress the biasing mechanism. The biasing mechanism may be configured to establish a clamping force. The pair of tangs may be connected to the rod and may be configured to transition between an extended position and a compressed position. The tangs may be configured to engage a second surface of the work piece.

[0095] The descriptions of the different illustrative embodiments have been presented for purposes of illustration and description, and are not intended to be exhaustive or limited to the embodiments in the form disclosed. Many modifications and variations may be apparent to those of ordinary skill in the art. Further, different illustrative embodiments may provide different features as compared to other illustrative embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the embodiments, the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

[0096] Further, the disclosure comprises embodiments according to the following clauses:

Clause 1: An apparatus for clamping a work piece (302) at a maximum force, the apparatus comprising: a body (330), a first end (334) of the body (330) configured to engage a first surface (312) of the work piece (302), the body (330) having an interior region (332), the body (330) also having an axial length (331); a rod (340) positioned partially within the body (330), the rod (340) configured to move along the axial length (331) of the body (330) and threading positioned on the rod (340); a cap (320) attached to the rod (340) such that rotating the cap (320) causes the cap (320) to move axially along the rod (340); a biasing mechanism (360) connected to the rod (340), the body (330), and the cap (320) configured such that axial movement of the rod (340) beyond a desired point engages the biasing mechanism (360), and rotation of the cap (320) configured to compress the biasing mechanism (360), the biasing mechanism (360) configured to establish a clamping force; and a pair of tangs (341) connected to the rod (340), the tangs (341) configured to transition between an extended position (346) and a compressed position (345), wherein the tangs (341) are configured to engage a second surface (313) of the work piece (302).

Clause 2: The apparatus of clause 1, further comprising a clutch (370) configured to attach to the cap (320).

Clause 3: The apparatus of clause 2, wherein the clutch (370) is a reversible clutch (371) such that attaching the clutch (370) in a first configuration rotates the cap (320) in a first direction and attaching the clutch (370) in a second configuration rotates the

cap (320) in a second direction.

Clause 4: The apparatus of clause 2, wherein the tangs (341) comprise a pair of teeth (342).

Claims

1. A clamp (303) comprising:

   a body (330) having an interior region (332) and having a first end (334) configured to contact a first surface (312) of a work piece (302);
   a fastener system configured to move within the interior region (332) of the body (330) and through a hole (315) in the work piece (302) to a second surface (313) of the work piece (302) in which the fastener system has a second end (335) configured to engage the second surface (313) of the work piece (302); and
   a biasing mechanism (360) connected to the fastener system in which the biasing mechanism (360) is configured to apply a force on the fastener system to cause the second end (335) of the fastener system and the body (330) to engage the work piece (302) at a desired level of force at different levels of extension of the fastener system, wherein the fastener system comprises a rod (340) configured to move axially relative to the body (330), the rod (340) having threads (349); and a cap (320) threadedly attached to the rod (340) such that rotating the cap (320) causes the rod (340) to move along an axial length (331) of the rod (340)
   characterized by a clutch (370) configured to attach to the cap (320) and configured to set the desired level of force for the fastener system, and
   wherein the clutch (370) is configured to disengage from the cap (320) after the cap (320) advances a desired distance along the rod (340).

2. The clamp (303) of claim 1, wherein the biasing mechanism (360) comprises a spring (361).

3. The clamp (303) of claim 1, wherein the clutch (370) is a reversible clutch (371).

4. The clamp (303) of claim 1, further comprising a nut (347) and a nut engager (350) configured to prevent rotation of the rod (340) and to allow axial motion of the rod (340).

5. The clamp (303) of claim 4, wherein the nut (347) comprises a hex nut (348) and the nut engager (350) comprises a hex nut receiving region (352).

6. The clamp (303) of claim 5, wherein the nut (347) and the hex nut receiving region (352) are configured such that the nut (347) may move axially within the nut engager (350).

7. The clamp (303) of claim 1, further comprising a pair of tangs (341) and a tang extender (343) attached to the body (330), the pair of tangs (341) being biased to a compressed position (345), and the tang extender (343) configured to move the pair of tangs (341) to an extended position (346).

8. The clamp (303) of claim 7, wherein the pair of tangs (341) comprises teeth (342) configured to engage a surface of the work piece (302).

9. The clamp (303) of claim 1, further comprising a positioner (397) configured to bias the rod (340) against a stop (392) of the body (330).

10. A method for clamping a work piece (302) at a desired force, the method comprising:

    inserting a pair of tangs (341) through a hole (315) of the work piece (302);
    rotating a cap (320) connected to a rod (340) in a first direction such that the tangs (341) engage a surface of the work piece (302); and
    compressing a biasing mechanism (360) to establish a clamping force, **characterized in that** the step of rotating the cap (320) further comprises attaching a clutch (370) to the cap (320) and rotating the clutch (370), and wherein rotating the clutch (370) extends the rod (340) to a distance and the clutch (370) then disengages the cap (320).

Patentansprüche

1. Klemme (303), mit:

   einem Körper (330), der einen Innenbereich (332) und ein erstes Ende (334) aufweist, das dazu ausgebildet ist, eine erste Oberfläche (312) eines Werkstücks (302) zu kontaktieren;
   einem Befestigungssystem, das dazu ausgebildet ist, mit dem Innenbereich (332) des Körpers (330) sich durch ein Loch (315) in dem Werkstück (302) zu einer zweiten Oberfläche (313) des Werkstücks (302) zu bewegen, wobei das Befestigungssystem ein zweites Ende (335) aufweist, das dazu ausgebildet ist, mit der zweiten Oberfläche (313) des Endstücks (302) ineinander zu greifen; und
   einem Vorspannungsmechanismus (360), der mit dem Befestigungssystem verbunden ist, wobei der Vorspannungsmechanismus (360) dazu ausgebildet ist, eine Kraft auf das Befestigungs-

system zu eaufschlagen, um zu bewirken, dass das zweite Ende (335) des Befestigungssystems und der Körper (330) mit dem Werkstück (302) mit einem gewünschten Kraftniveau auf verschiedenen Ausstreckungsniveaus des Befestigungssystems ineinandergreifen,
wobei das Befestigungssystem einen Stab (340), der dazu ausgebildet ist, sich axial relativ zu dem Körper (330) zu bewegen, wobei der Stab (340) ein Gewinde (349) aufweist; und eine Kappe (320) aufweist, die mittels des Gewindes an der Stange (340) angebracht ist, so dass die Kappe (320) bewirkt, dass die Stange (340) sich entlang einer axialen Länge (331) des Stabs (340) bewegt
gekennzeichnet durch eine Kupplung (370), die dazu ausgebildet ist, an der Kappe (320) angebracht zu werden, und die dazu ausgebildet ist, das gewünschte Kraftniveau für das Befestigungssystem einzustellen, und
wobei die Kupplung (370) dazu ausgebildet ist, sich von der Kappe (320) außer Eingriff zu lösen, nachdem die Kappe (320) eine gewünschte Distanz entlang des Stabs (340) vorangeschritten ist.

2. Klemme (303) nach Anspruch 1, wobei der Vorspannungsmechanismus (360) eine Feder (361) aufweist.

3. Klemme (303) nach Anspruch 1, wobei die Kupplung eine Umkehrkupplung (371) ist.

4. Klemme (303) nach Anspruch 1, des Weiteren mit einer Mutter (347) und einem Muttereingriffselement (350), das dazu ausgebildet ist, eine Rotation des Stabs (340) zu vermeiden und eine axiale Bewegung des Stabs (340) zu ermöglichen.

5. Klemme (303) nach Anspruch 4, wobei die Mutter (347) eine Hex-Mutter (348) ist und das Muttereingriffselement (350) einen Hex-Mutterempfangsbereich (352) aufweist.

6. Klemme (303) nach Anspruch 5, wobei die Mutter (347) und der Hex-Mutterempfangsbereich (352) derart ausgebildet sind, dass die Mutter (347) sich axial mit dem Muttereingriffselement (350) bewegen kann.

7. Klemme (303) nach Anspruch 1, des Weiteren mit einem Paar von Zungen (341) und einem Zungenaustrecker (343), der mit dem Körper (330) verbunden ist, wobei das Paar von Zungen (341) in eine zusammengedrückte Position (345) vorgespannt ist, und wobei der Zungenaustrecker (343) dazu ausgebildet ist, das Paar von Zungen (341) in eine ausgestreckte Position (346) zu bewegen.

8. Klemme (303) nach Anspruch 7, wobei das Paar von Zungen (341) Zähne (342) aufweist, die dazu ausgebildet sind, mit einer Oberfläche des Werkstücks (302) einzugreifen.

9. Klemme (303) nach Anspruch 1, des Weiteren mit einem Positionierelement (347), das dazu ausgebildet ist, die Stange (340) gegen ein Stoppelement (392) des Körpers (330) vorzuspannen.

10. Verfahren zum Klemmen eines Werkstücks (302) mit einer gewünschten Kraft, wobei das Verfahren die folgenden Schritte aufweist:

Einfügen eines Paars von Zungen (341) durch ein Loch (315) des Werkstücks (302);
Rotieren einer Kappe (320), die mit einem Stab (340) verbunden ist, in eine erste Richtung, so dass die Zungen (341) in eine Oberfläche des Werkstücks (302) eingreifen; und
Zusammendrücken eines Vorspannungsmechanismus (360) zum Erzeugen einer Klemmkraft, **dadurch gekennzeichnet, dass** der Schritt des Rotierens der Kappe (320) des Weiteren das Anbringen einer Kupplung (370) an die Kappe (320) und das Rotieren der Kupplung (370) aufweist, wobei das Rotieren der Kupplung (370) die Stange (340) in eine Distanz ausstreckt und die Kupplung (370) dann die Kappe (320) loslässt.

Revendications

1. Dispositif de fixation par serrage (303) comprenant :

un corps (330) comportant une région intérieure (332) et comportant une première extrémité (334) configurée pour venir en contact avec une première surface (312) d'une pièce (302) ;
un système de fixation configuré pour se déplacer à l'intérieur de la région intérieure (332) du corps (330) et à travers un trou (315) dans la pièce (302) jusqu'à une seconde surface (313) de la pièce (302), le système de fixation comportant une seconde extrémité (335) configurée pour venir en prise avec la seconde surface (313) de la pièce (302) ; et
un mécanisme de sollicitation (360) raccordé au système de fixation, le mécanisme de sollicitation (360) étant configuré pour appliquer une force sur le système de fixation de façon à amener la seconde extrémité (335) du système de fixation et le corps (330) à venir en prise avec la pièce (302) avec une force d'une intensité souhaitée à différents degrés d'extension du système de fixation, le système de fixation comprenant une tige (340) configurée pour se déplacer

axialement par rapport au corps (330), la tige (340) comportant des filets (349) ; et un chapeau (320) attaché par vissage à la tige (340) de telle sorte qu'une rotation du chapeau (320) amène la tige (340) à se déplacer le long d'une longueur axiale (331) de la tige (340),
caractérisé par un embrayage (370) configuré pour s'attacher au chapeau (320) et configuré pour régler l'intensité de force souhaitée pour le système de fixation, et l'embrayage (370) étant configuré pour se désaccoupler du chapeau (320) une fois que le chapeau (320) a avancé d'une distance souhaitée le long de la tige (340).

2. Dispositif de fixation par serrage (303) selon la revendication 1, dans lequel le mécanisme de sollicitation (360) comprend un ressort (361).

3. Dispositif de fixation par serrage (303) selon la revendication 1, dans lequel l'embrayage (370) est un embrayage réversible (371).

4. Dispositif de fixation par serrage (303) selon la revendication 1, comprenant en outre un écrou (347) et un élément destiné à venir en prise avec l'écrou (350) configuré pour empêcher toute rotation de la tige (340) et pour permettre un mouvement axial de la tige (340).

5. Dispositif de fixation par serrage (303) selon la revendication 4, dans lequel l'écrou (347) comprend un écrou hexagonal (348) et l'élément destiné à venir en prise avec l'écrou (350) comprend une région de réception d'écrou hexagonal (352).

6. Dispositif de fixation par serrage (303) selon la revendication 5, dans lequel l'écrou (347) et la région de réception d'écrou hexagonal (352) sont configurés de telle sorte que l'écrou (347) puisse se déplacer axialement à l'intérieur de l'élément destiné à venir en prise avec l'écrou (350).

7. Dispositif de fixation par serrage (303) selon la revendication 1, comprenant en outre une paire de pointes (341) et un élément de déploiement de pointes (343) attaché au corps (330), la paire de pointes (341) étant sollicitée vers une position comprimée (345), et l'élément de déploiement de pointes (343) étant configuré pour déplacer la paire de pointes (341) jusqu'à une position déployée (346).

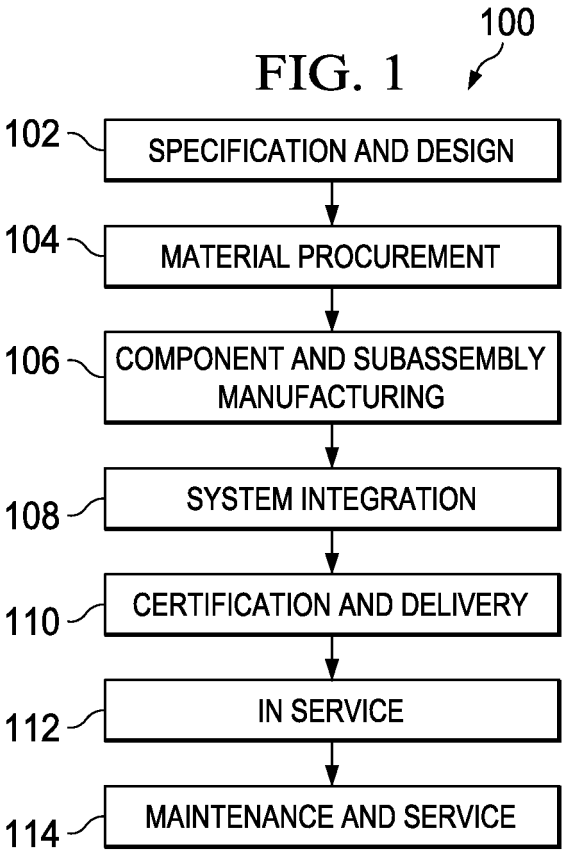
8. Dispositif de fixation par serrage (303) selon la revendication 7, dans lequel la paire de pointes (341) comprend des dents (342) configurées pour venir en prise avec une surface de la pièce (302).

9. Dispositif de fixation par serrage (303) selon la revendication 1, comprenant en outre un dispositif de positionnement (397) configuré pour solliciter la tige (340) contre une butée (392) du corps (330).

10. Procédé de fixation par serrage d'une pièce (302) avec une force souhaitée, le procédé comprenant :

insérer une paire de pointes (341) à travers un trou (315) de la pièce (302) ;
faire tourner un chapeau (320) raccordé à une tige (340) dans une première direction de telle sorte que les pointes (341) viennent en prise avec une surface de la pièce (302) ; et
comprimer un mécanisme de sollicitation (360) afin d'établir une certaine force de fixation par serrage, **caractérisé en ce que** l'étape consistant à faire tourner le chapeau (320) comprend en outre le fait d'attacher un embrayage (370) au chapeau (320) et de faire tourner l'embrayage (370), et dans lequel le fait de faire tourner l'embrayage (370) étend la tige (340) d'une certaine distance et l'embrayage (370) se désaccouple alors du chapeau (320).

FIG. 1


100
102
SPECIFICATION AND DESIGN
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MATERIAL PROCUREMENT
106
COMPONENT AND SUBASSEMBLY MANUFACTURING
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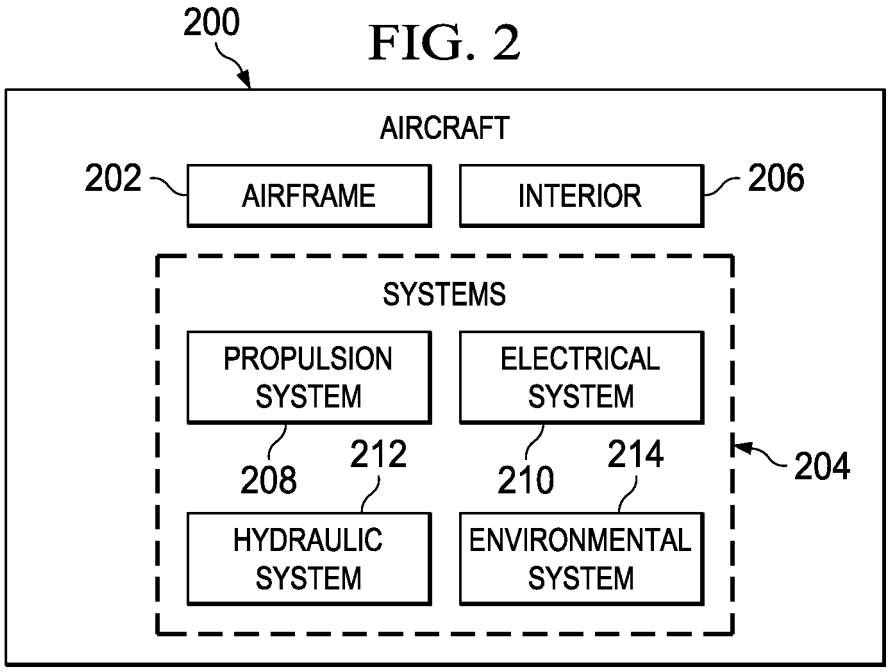
SYSTEM INTEGRATION
110
CERTIFICATION AND DELIVERY
112
IN SERVICE
114
MAINTENANCE AND SERVICE

FIG. 2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AIRCRAFT
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AIRFRAME
INTERIOR
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PROPULSION SYSTEM
ELECTRICAL SYSTEM
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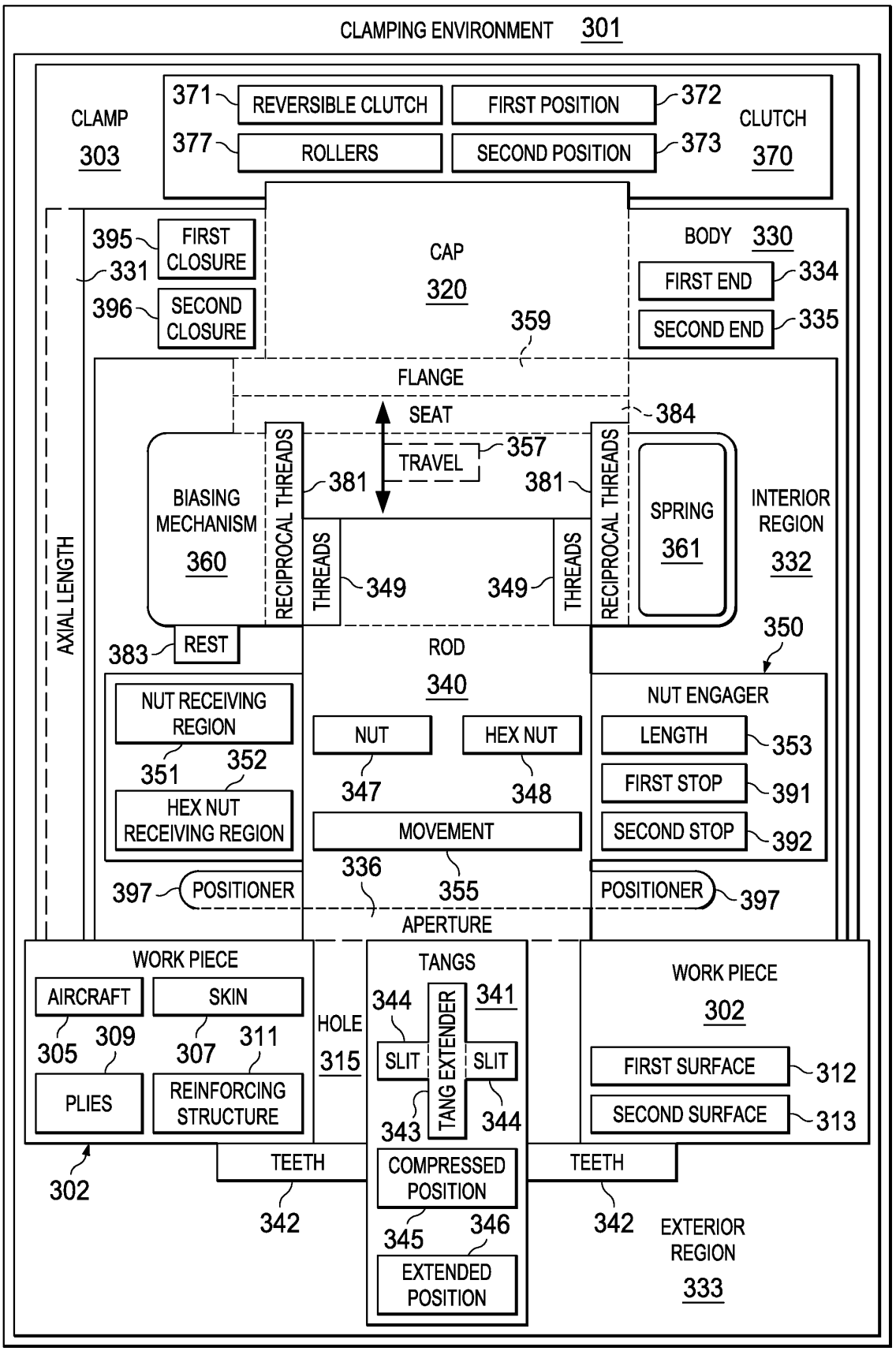
214
204
HYDRAULIC SYSTEM
ENVIRONMENTAL SYSTEM

FIG. 3


CLAMPING ENVIRONMENT 301
CLAMP 303
371 REVERSIBLE CLUTCH
FIRST POSITION 372
377 ROLLERS
SECOND POSITION 373
CLUTCH 370
395 FIRST CLOSURE
331
396 SECOND CLOSURE
CAP 320
359
BODY 330
FIRST END 334
SECOND END 335
FLANGE
SEAT
384
357
TRAVEL
381
381
BIASING MECHANISM 360
RECIPROCAL THREADS
THREADS
349
349
THREADS
RECIPROCAL THREADS
SPRING 361
INTERIOR REGION 332
AXIAL LENGTH
383 REST
ROD 340
350
NUT RECEIVING REGION
351
352
HEX NUT RECEIVING REGION
NUT
HEX NUT
347
348
MOVEMENT
NUT ENGAGER
LENGTH 353
FIRST STOP 391
SECOND STOP 392
336
355
397 POSITIONER
POSITIONER 397
APERTURE
WORK PIECE
AIRCRAFT
SKIN
305
309
307
311
PLIES
REINFORCING STRUCTURE
HOLE 315
TANGS
344
341
SLIT
TANG EXTENDER
SLIT
343
344
WORK PIECE 302
FIRST SURFACE 312
SECOND SURFACE 313
302
TEETH
342
COMPRESSED POSITION
TEETH
342
345
346
EXTENDED POSITION
EXTERIOR REGION 333

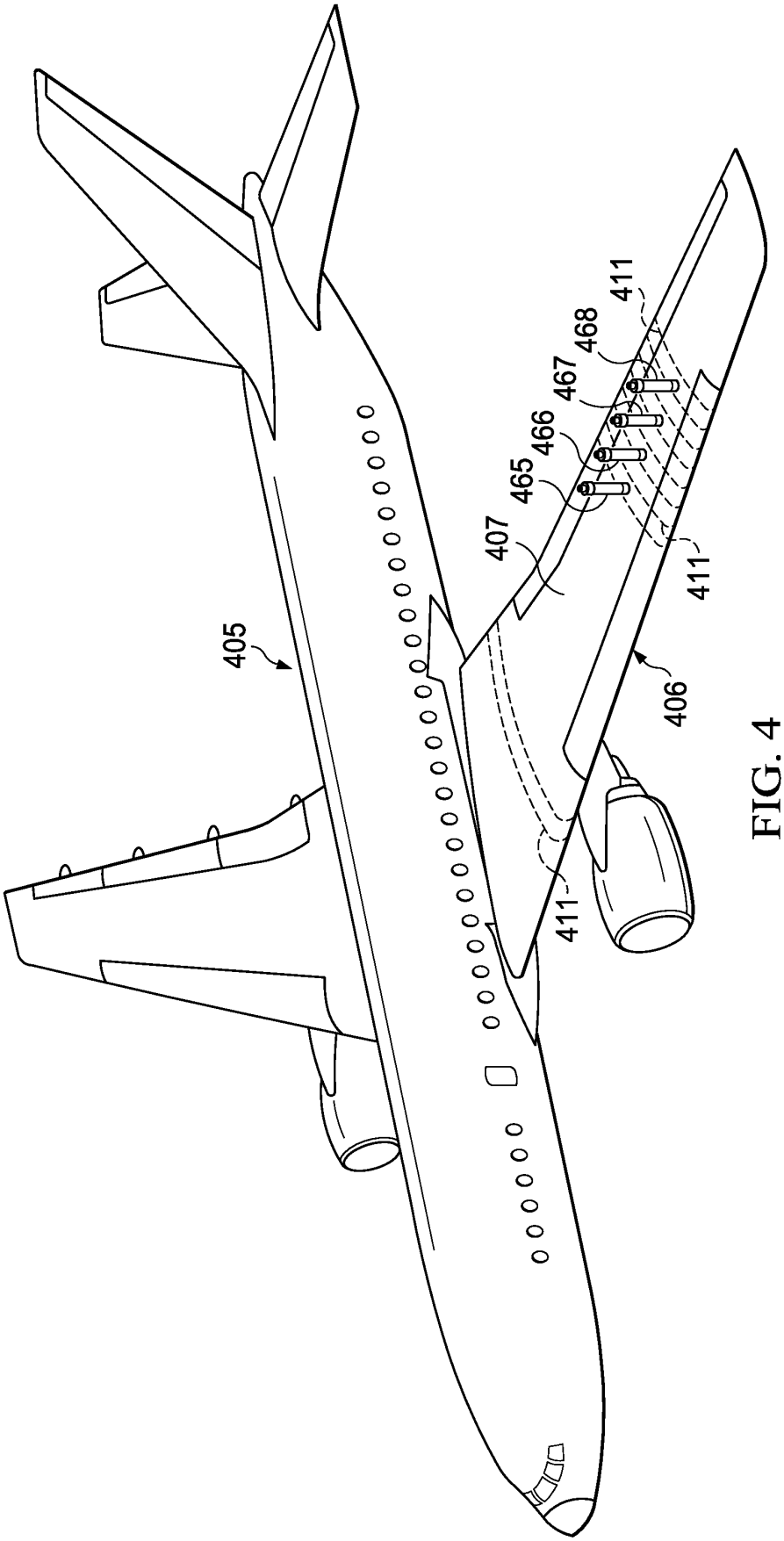


FIG. 4

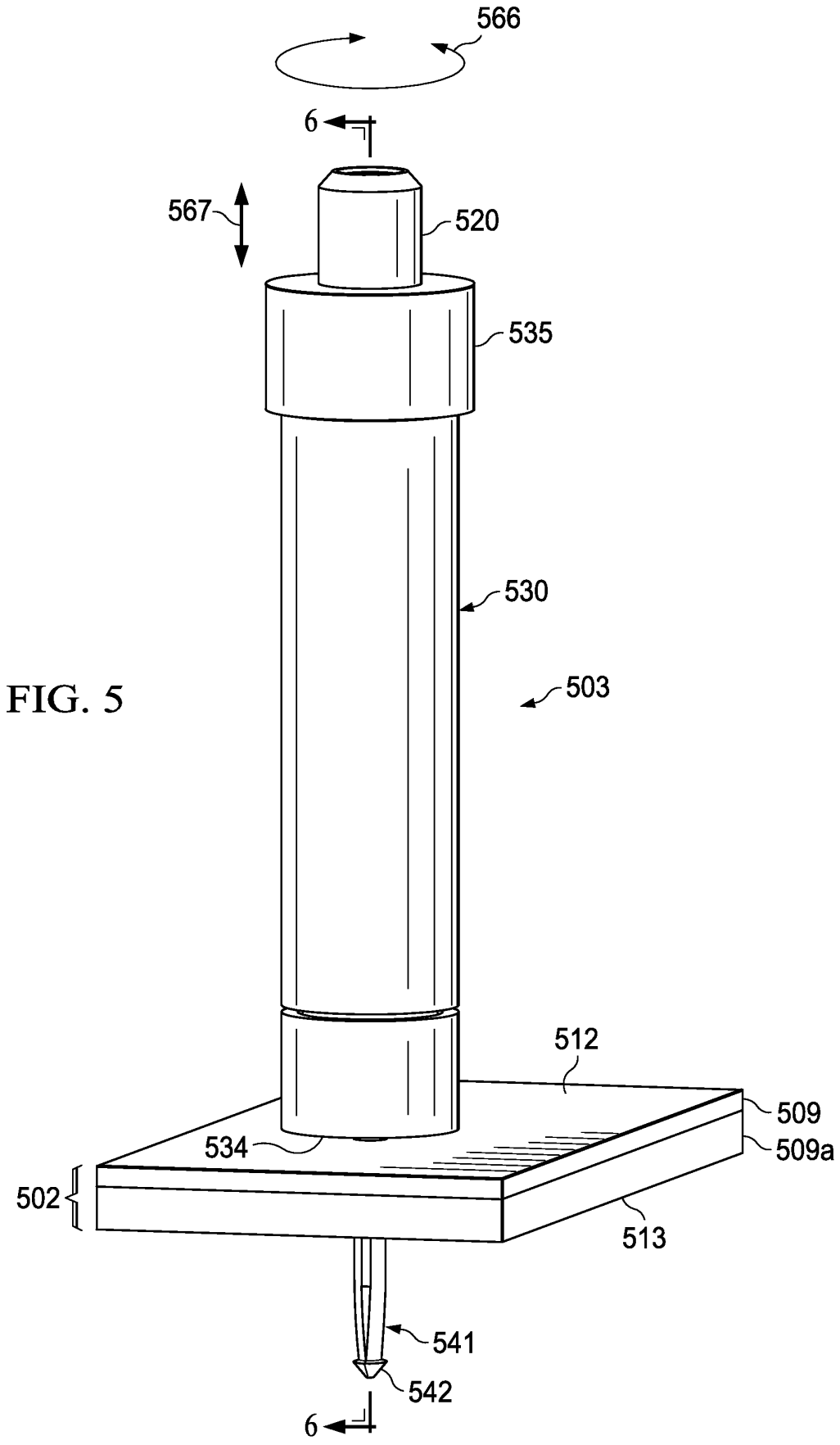


FIG. 5

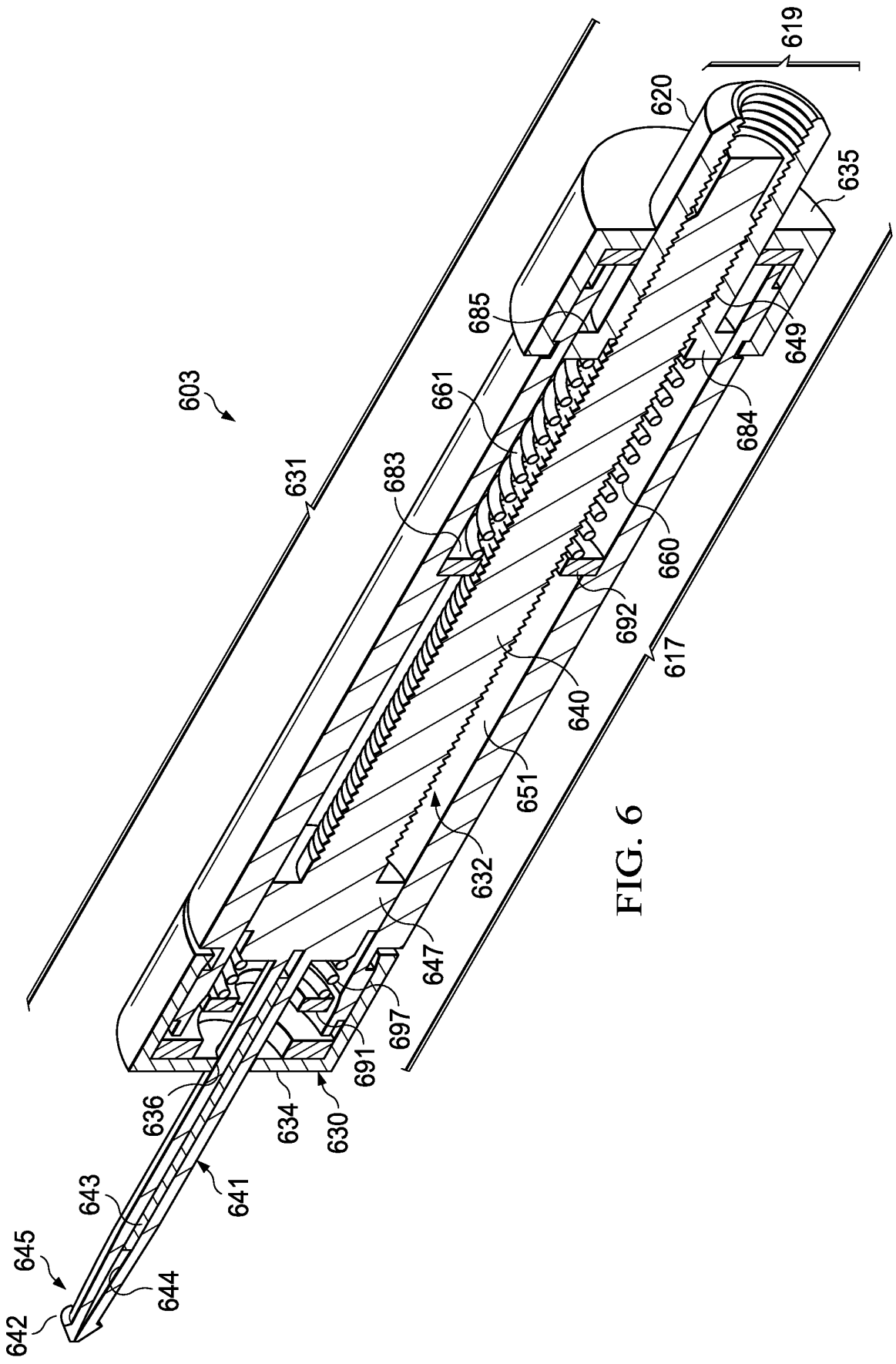

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FIG. 6

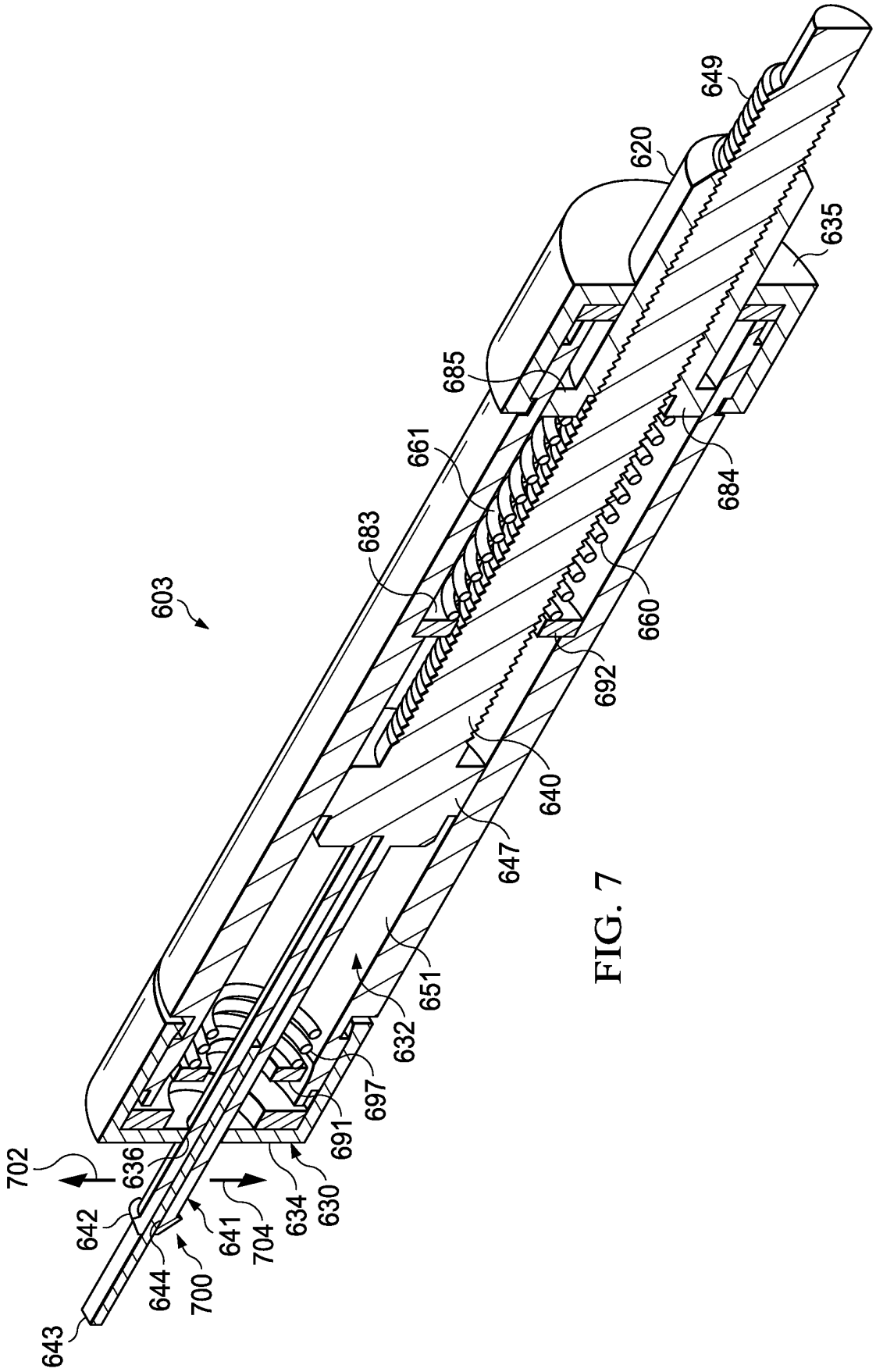
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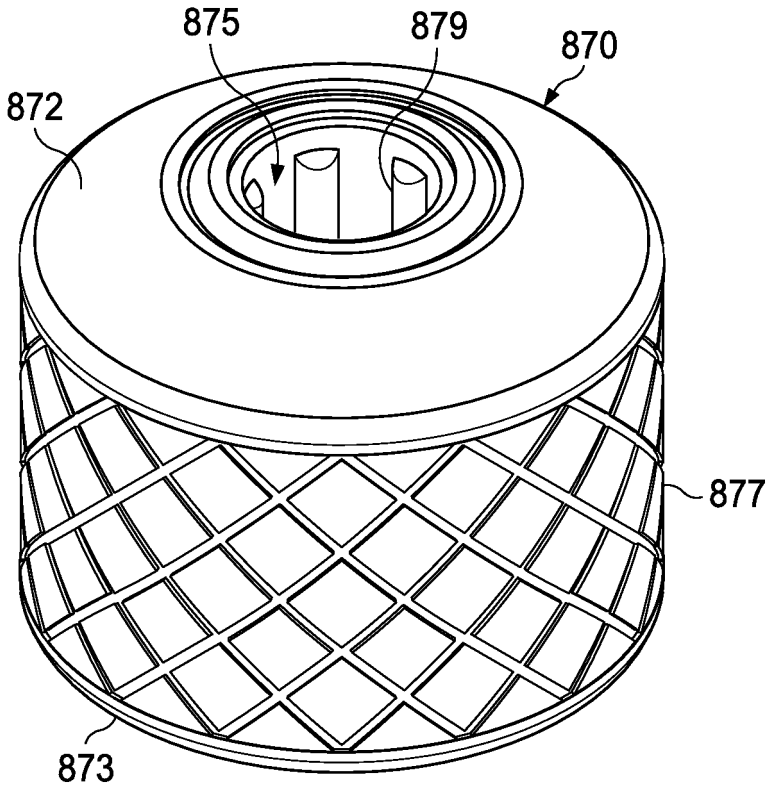
FIG. 7

FIG. 8



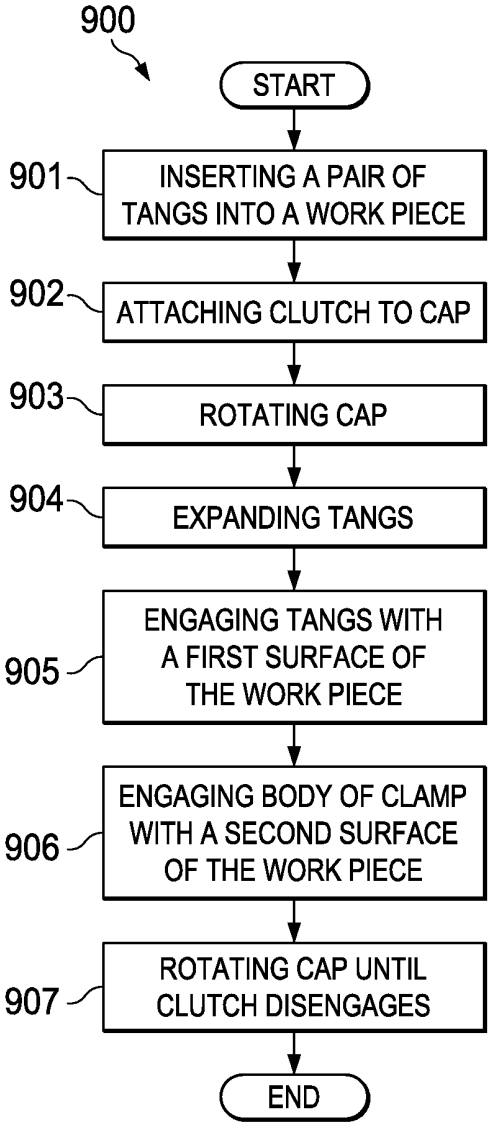

900
START
901
INSERTING A PAIR OF TANGS INTO A WORK PIECE
902
ATTACHING CLUTCH TO CAP
903
ROTATING CAP
904
EXPANDING TANGS
905
ENGAGING TANGS WITH A FIRST SURFACE OF THE WORK PIECE
906
ENGAGING BODY OF CLAMP WITH A SECOND SURFACE OF THE WORK PIECE
907
ROTATING CAP UNTIL CLUTCH DISENGAGES
END

FIG. 9

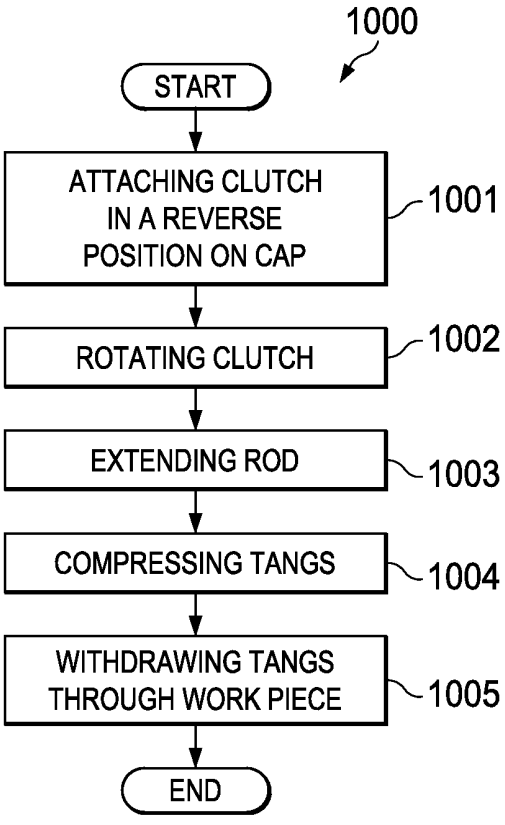

1000
START
ATTACHING CLUTCH IN A REVERSE POSITION ON CAP
1001
ROTATING CLUTCH
1002
EXTENDING ROD
1003
COMPRESSING TANGS
1004
WITHDRAWING TANGS THROUGH WORK PIECE
1005
END

FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2011088242 A1 **[0007]**
- US 5042787 A **[0007]**
- EP 0466609 A1 **[0008]**