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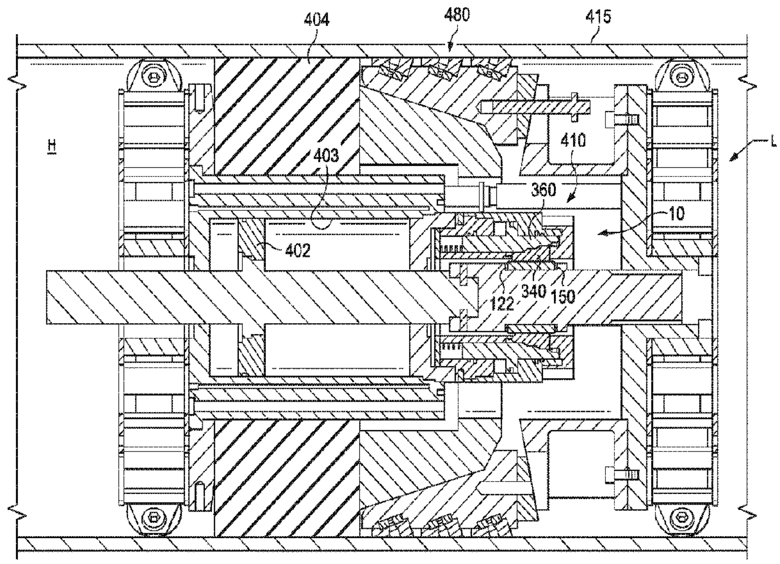

(57) Abrégé/Abstract:
A mechanical lock unit (10, 100, 210, 410) with a shaft lock assembly (12) and method of achieving a self-lock mode for, e.g., hydraulically activated isolation plug module. The shaft lock assembly (12) includes a teeth-form ring (30, 130, 230) that surrounds a shaft (14, 114, 214). The teeth-form ring (30, 130, 230) defines a plurality of teeth (38, 138, 238). A teeth-form split gripper assembly (340) is positioned to surround the teeth-form ring (30, 130, 230). The teeth-form split gripper assembly (340) has at least a first teeth-form split gripper (342) and a second teeth-form split gripper (344) with a spring (346) therebetween for biasing the first teeth-form split gripper (342) away from said second teeth-form split gripper (344). The first teeth-form split gripper (342) and the second teeth form split gripper (344) having an inner surface (348) that defines a plurality of teeth (350) for cooperative engagement with the plurality of teeth (38, 138, 238) of the teeth-form ring (30, 130, 230).

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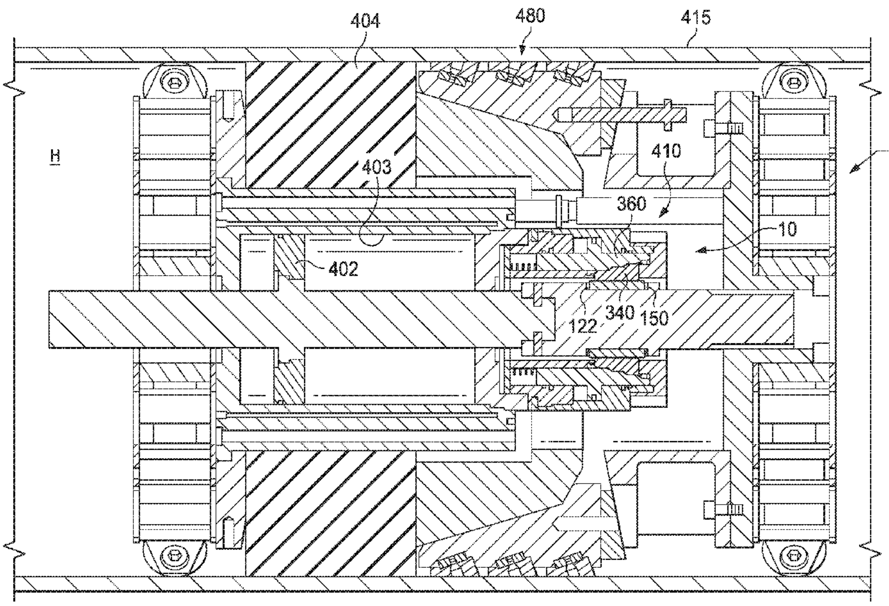

FIG. 8

(57) Abstract: A mechanical lock unit (10, 100, 210, 410) with a shaft lock assembly (12) and method of achieving a self-lock mode for, e.g., hydraulically activated isolation plug module. The shaft lock assembly (12) includes a teeth-form ring (30, 130, 230) that surrounds a shaft (14, 114, 214). The teeth-form ring (30, 130, 230) defines a plurality of teeth (38, 138, 238). A teeth-form split gripper assembly (340) is positioned to surround the teeth-form ring (30, 130, 230). The teeth-form split gripper assembly (340) has at least a first teeth-form split gripper (342) and a second teeth-form split gripper (344) with a spring (346) therebetween for biasing the first teeth-form split gripper (342) away from said second teeth-form split gripper (344). The first teeth-form split gripper (342) and the second teeth form split gripper (344) having an inner surface (348) that defines a plurality of teeth (350) for cooperative engagement with the plurality of teeth (38, 138, 238) of the teeth-form ring (30, 130, 230).

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SHAFT MECHANICAL LOCK FOR PIPELINE ISOLATION TOOLS

FIELD OF THE INVENTION

[0001] The technical field of the invention is the mechanical field, specifically hydraulics. More particularly, the invention relates to a lock for a hydraulically activated isolation plug module, when the latter is used to isolate pipelines.

BACKGROUND OF THE INVENTION

[0002] A pipeline isolation module is provided for isolating pressurized pipelines so that equipment maintenance, repairs, and replacements can be done without bleeding down an entire system. Typical uses for a pipeline isolation module include valve replacement, riser and midrise repair, tie-ins, dropped objection protection during construction, hydrotesting, and trap installation. The plug is used to isolate the pressure inside the pipeline by setting a sealing rubber packer against a hydraulic cylinder. A typical isolation plug is locked by hydraulic actuation.

[0003] The pipeline isolation tool or plug is used to isolate pressure inside a pipeline by setting a sealing rubber packer against a hydraulic cylinder. Typically, the isolation plug is locked by hydraulic actuation.

[0004] Pipeline isolation tools typically utilize hydraulic force to set the tool. Setting the tool securely is important to eliminate any rotation or axial movement of the shaft that can damage the shaft surface.

SUMMARY OF THE INVENTION

[0005] The pipeline isolation tool of the invention utilizes a shaft mechanical lock to mechanically lock the shaft of an isolation plug module from axial movement by using teeth engagement between a teeth-form ring on the shaft and teeth-form split grippers in the mechanical lock unit.

[0006] The device of the invention can be used to mechanically lock the position of the shaft by the engagement of two teeth-form parts, i.e., the teeth-form split grippers in the mechanical lock unit and the teeth-form ring on the shaft. The spring-loaded lock piston functions to maintain teeth engagement, which prevents the shaft from moving in an axial direction. The teeth engagement differs from thread engagement, i.e., teeth engagement in the tool of the invention utilizes parallel teeth so that the shaft can still rotate without becoming disengaged. The tool of the invention can be used to mechanically lock a hydraulically activated isolation plug module for isolating pipelines. Mechanically locking the pipeline isolation tool acts as a safeguard when the hydraulic lock is lost, e.g., when there is a leak in the hydraulic system.

[0007] Engagement of the teeth-form split grippers together with the horizontal hold of the spring-loaded lock piston increases the ability to hold the shaft at very high loads.

[0008] The tool of the invention, therefore, increases reliability of the lock and, therefore, increases reliability of the seal, and also reduces the risk of losing the lock, thereby reducing the overall risk of operational failure.

[0009] The shaft mechanical lock may be used with isolation plugs having an existing hydraulic system and offers the possibility to isolate from a high “back pressure”.

[0010] The tool of the invention can be used to mechanically lock the axial movement of all types of shafts that have a high working load with high lock reliability. The mechanical lock provides an additional safeguard for the hydraulic lock in addition to hydraulic actuation of a sealing packer.

[0011] One advantage is that the teeth engagement as well as the horizontal lock from the spring-loaded lock piston allow the dimensions of the design to be small while maintaining a high work load capacity.

[0012] In contrast to thread engagement, the parallel teeth engagement of the tool of the invention allows full rotation without losing engagement.

[0013] The tool of the invention includes teeth form split grippers, a teeth form ring on the shoulder and a spring loaded lock piston in the mechanical lock unit. Teeth-form split grippers are lifted up by the springs between them. Teeth of the teeth-form split grippers are positioned to engage teeth on a teeth-form ring on the shaft.

[0014] The teeth-form ring on the shaft may utilize a clearance fit with the shaft. The teeth-form ring on the shaft prevents damage to the shaft during the lock/unlock process. A spring or elastomeric member at the end of the teeth-form ring may be provided to ensure that the teeth-form ring can move slightly to the left or to the right to facilitate correct engagement with the teeth-form split grippers. In one embodiment, the teeth-form ring can be mounted in one step on the shaft and can be held by a retaining ring or a lock nut at one end.

[0015] The teeth-form split grippers are assembled with a housing, lock piston, and lid as one unit (called the mechanical lock unit). The teeth-form ring is assembled to the shaft, e.g., with a clearance fit, and held by a retaining ring or lock nut. The mechanical lock unit is then mounted at the locked position of the shaft.

[0016] In use, the isolation plug is pigged through a pipeline to an isolation set location. The mechanical lock unit is put into and unlock state. Hydraulic pressure is applied to the plug cylinder to move a plug piston and set a rubber packer. After the packer is fully set, hydraulic force inside the mechanical lock unit is released so that a spring force pushes the lock piston of the mechanical lock unit into a locked state. The teeth engagement holds the isolation plug in place together with the hydraulic force inside the isolation plug.

[0017] In the normal locked state, the spring-loaded lock piston in the mechanical lock unit compresses the teeth-form split gripper assembly and the springs between teeth-form split grippers. Compression of the teeth-form split gripper assembly causes the teeth-form split grippers to engage with the teeth-form ring that holds and locks the axial movement of the shaft. The parallel, circumferential orientation of the teeth, rather than a threaded orientation, allows the shaft to rotate without losing the engagement. Horizontal contact between a lock piston and the split grippers, as well as teeth engagement, result in transferring all of the load of the plug piston to the strong lid of the mechanical lock unit. Therefore, even though the dimensions of the tool of the invention may be small, the tool of the invention can hold a very heavy load.

[0018] To unlock the mechanical lock unit, a hydraulic force is applied to the spring-loaded lock piston to overcome its spring force for pushing the piston into an unlocked position. When there is no applied force from the lock piston, the teeth-form split grippers are lifted up by the springs between the teeth form split grippers. Teeth engagement between the split grippers of the teeth form split gripper assembly and the teeth form ring of the shaft is, therefore, removed and the shaft is unlocked and is free to move.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Figure 1A shows a cross-sectional view of a shaft surrounded by the teeth-form split grippers of the invention in an unlocked state.

[0020] Figure 1B shows a cross-sectional view of a shaft surrounded by the teeth-form split grippers of Figure 1A in a locked state.

[0021] Figure 2 shows a first embodiment wherein the teeth-form ring is received on an end of a shaft.

[0022] Figure 3 shows an end view of a second embodiment or bifurcated teeth form ring.

[0023] Figure 4 shows a side view of the bifurcated teeth form ring of Figure 3.

[0024] Figure 5 shows an elevation view of a third embodiment or slotted teeth form ring.

[0025] Figure 6 is a perspective view of an inline isolation plug module.

[0026] Figure 7 is a cross-sectional view of the plug module of Figure 6 shown in an unset state.

[0027] Figure 8 is a cross-sectional view of the plug module of Figure 6 shown in a set state wherein a piston is locked by the mechanical lock.

[0028] Figure 9 shows an enlarged section of the plug module of Figure 7 wherein the second embodiment or bifurcated teeth-form ring of Figures 3 and 4 received in a recessed area of a shaft as part of a mechanical lock unit shown in an unset state.

[0029] Figure 10 shows an enlarged section of the plug module of Figure 9 wherein the second embodiment or bifurcated teeth-form ring of Figures 3 and 4 received in a recessed area of a shaft as part of a mechanical lock unit shown in a set state.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] Mechanical lock unit **10** includes shaft lock assembly **12**. Shaft lock assembly **12** includes shaft **14**. In one embodiment, shaft **14** defines first diameter portion **16**, second diameter portion **18** and first annular surface **20**. First annular surface **20** is located between first diameter portion **16** and second diameter portion **18**.

[0031] First resilient ring **22** surrounds second diameter portion **18** of shaft **14**. First resilient ring **22** has first side **24** that is adjacent to first annular surface **20** of shaft **14**.

[0032] Teeth form ring **30** surrounds second diameter portion **18** of shaft **14**. Teeth form ring **30** has first end **32**, second end **34**, and outer surface **36** (FIG. 2). Outer surface **36** defines plurality of teeth **38**. First end **32** is positioned adjacent to first resilient ring **22**.

[0033] Still referring to FIG. 2, second resilient ring **50** surrounds second diameter portion **18** of shaft **14**. Second resilient ring **50** is adjacent to second end **34** of teeth form ring **30**.

[0034] Retain ring or lock ring **60** surrounds second diameter portion **18** of shaft **14**. Retain ring **60** is positioned adjacent to second resilient ring **50**.

[0035] A second embodiment, i.e., mechanical lock unit **100**, includes shaft lock assembly **112** (FIGS. 3, 4). Shaft lock assembly **112** includes shaft **114**. Shaft **114** defines first diameter portion **116**, second diameter portion **118**, and third diameter portion **119** (FIG. 10). First diameter portion **116** and third diameter portion **119** may be the same diameter. Shaft **114** additionally defines first annular surface **120** between first diameter portion **116** and second diameter portion **118**. Shaft **114** additionally defines second annular surface **121** between second diameter portion **118** and third diameter portion **119**.

[0036] First resilient ring **122** surrounds second diameter portion **118** of shaft **114**. First resilient ring **122** has a first side adjacent to first annular surface **120** of shaft **114**.

[0037] A second embodiment of the teeth form ring is teeth form ring **130** (FIGS. 3 and 4). Teeth form ring **130** surrounds second diameter portion **118** of shaft **114**. Teeth form ring

130 has first end **132** and second end **134**. Teeth form ring **130** additionally has outer surface **136**. Outer surface **136** defines a plurality of teeth **138**. Teeth form ring **138** is made up of first half **140** and second half **142**. First end **132** is located adjacent to first resilient ring **122**. Teeth form ring **130** additionally includes first connector **144** for connecting first half **140** and second half **142**. Teeth form ring **130** also includes second connector **146** for connecting first half **140** and second half **142**.

[0038] Second resilient ring **150** surrounds second diameter portion **118** of shaft **114**. Second resilient ring **150** is positioned adjacent to second end **134** of teeth form ring **130** and also adjacent to second annular surface **121** of shaft **114**.

[0039] A third embodiment of mechanical lock unit **210** includes shaft lock assembly designated **212** (FIG. 5). Shaft lock assembly **212** includes slotted teeth form ring **230**. Shaft lock assembly **212** includes shaft **214**. Shaft **214** includes bolt **215** that extends radially from shaft **214**. Shaft **214** defines a first diameter portion **216** and a second diameter portion **218**. Shaft **214** defines a first annular surface **220** between first diameter portion **216** and second diameter portion **218**.

[0040] Slotted teeth form ring **230** defines slot **231** for receiving bolt **215**. Slotted teeth form ring **230** may be constructed of two halves, similar to teeth form ring **130**, above. Bolt **215** is provided for securing teeth form ring **230** on shaft **214**, and for allowing axial travel of slotted teeth form ring **230** on shaft **214** to facilitate teeth engagement. Slotted teeth form ring **230** has outer section **236** that defines a plurality of teeth **238**. Resilient rings, e.g., **22**, **50** and **150** also facilitate axial movement of teeth from ring **30**, **130**, **230** to ensure full engagement of teeth **38**, **138** or **238** and teeth **350** of teeth from split gripper assembly **340**. In one embodiment, bolt **215** is threadably received in a threaded hole on shaft **214**.

[0041] Referring now to FIGS. 9 and 10, mechanical lock unit **10** may include rear lid **300**. Rear lid **300** defines inner portion **302** and outer portion **304**. Inner portion **302** defines inside surface **306** and outer surface **308**. Inside surface **306** surrounds first diameter portion **116** of shaft **114** that is adjacent to first annular surface **120** of shaft **114**. Outer portion **304** of rear lid **300** defines an inner surface **310** and a first surface **312**. Although mechanical lock unit **10** is shown with second embodiment components, e.g., shaft **114** and shaft lock assembly **112**, it should be understood that similar construction may be obtained by using first embodiment components or third embodiment components that function in a similar way.

[0042] Front lid **320** at least partially surrounds third diameter portion **119** of shaft **114** and is adjacent to teeth form split gripper assembly **340**.

[0043] Teeth form split gripper assembly **340** is retained between rear lid **300** and front lid **320**. Teeth form split gripper assembly **340** is located to surround teeth form ring **130**. Teeth form split gripper assembly **340** has at least a first teeth form split gripper **342** (FIGS. 1A, 1B, 9, and 10) and a second teeth form split gripper **344** (FIGS. 1A, 1B). Spring **346** (FIGS. 1A, 1B) is located between at least first teeth form split gripper **342** and second teeth form split gripper **344** for biasing first teeth form split gripper **342** away from second teeth form split gripper **344**. Springs **346** may be located between all teeth from split grippers in teeth from split gripper assembly **340**.

[0044] First teeth form split gripper **342** and second teeth form split gripper **344** define inner surface **348**. Inner surface **348** defines a plurality of teeth **350**. Teeth **350** are provided for cooperative engagement with plurality of teeth **38**, **138**, and **238** of teeth form ring **30**, **130**, or **230**. Teeth form split gripper assembly **340** additionally defines an outer surface **352** that defines at least one ramp **354**.

[0045] A spring loaded lock piston **360** includes a first sliding portion **362** that defines a first end **364** and second ramp portion **366**. Second ramp portion **366** defines second end **368**. Flange portion **370** extends outwardly. Flange portion **370** defines a first surface **372** and a second surface **374**. First sliding portion **362** surrounds and is in sliding engagement with outer surface **308** of inner portion **302** of rear lid **300** and is also for sliding engagement with inner surface **310** of outer portion **304** of rear lid **300**. Second ramped portion **366** defines an inside surface for selective engagement with the at least one ramp **354** on outer surface **352** of teeth form split gripper assembly **340**.

[0046] Biasing member **380** is provided adjacent to first end **364** of lock piston **360** for biasing lock piston **360** towards engagement with teeth form split gripper assembly **340**.

[0047] Housing **390** defines a first portion that defines flange engaging surface **396**. Housing **390** defines a second portion that defines inside surface **398** for engaging outside surface **376** of second ramped portion **366** of spring loaded lock piston **360**. Housing **390** defines a second surface **399**.

[0048] Wherein first surface **372** of flange portion **370** of lock piston **360**, flange engaging surface **396**, and second surface **399** of housing **390** define flange receiving area **397** for receiving flange portion **370** of lock piston **360**.

[0049] A hydraulic force may be applied to the volume between second surface **374** of flange portion **370** and second surface **399** at housing **390** for forcing lock piston **360** away from engagement with teeth form split gripper assembly **340** thereby disengaging teeth form split gripper **342** from contact with teeth form ring **38**, **138**, or **238** and establishing an unlocked configuration for mechanical lock unit **10**.

[0050] A hydraulic force may be applied to the volume between first surface **372** of flange portion **370** and first surface **312** of rear lid **300** as a safeguard for forcing lock piston **360** into engagement with teeth form split gripper assembly **340**, thereby engaging teeth form split gripper **342** into contact with teeth form ring **38**, **138**, or **238** and establishing a locked configuration for mechanical lock unit **10**, **110** or **210**.

[0051] In use, isolation plug **400** (FIGS. 6-8) is pigged through a pipeline to an isolation set location. Mechanical lock unit **10**, **100**, **210** or **410** is put into an unlocked state. Hydraulic pressure is applied to move plug cylinder **402** (FIG. 8) and attached shaft **14**, **114**, **414** for setting rubber packer **404** (FIGS. 6-8). After packer **404** is fully set, the hydraulic force inside mechanical lock unit **10**, **100**, **210**, **410** is released so that a spring force of biasing member **380** pushes lock piston **360** of mechanical lock unit **410** into a locked state. The engagement of teeth **38** of teeth form ring **30**, **130**, or **230** and teeth **350** of teeth form split gripper assembly **340**, **440** holds the plug piston in place together with the hydraulic force inside isolation plug **400**.

[0052] In the normal locked state, the spring-loaded lock piston **360** in mechanical lock unit **10**, **110**, **210**, **410** compresses springs **346** between teeth-form split grippers, e.g., between **342** and **344**. Compression of the teeth-form split grippers causes teeth-form split grippers, e.g., between **342** and **344**, to engage with teeth-form ring **30**, **130**, or **230** that holds and locks axial movement of shaft **14**, **114**, **414**. In one embodiment, parallel, circumferential orientation of teeth **38**, **138**, or **238** and **350**, rather than a threaded orientation, allows shaft **14** to rotate without losing engagement. Horizontal contact at outer surface **352** between lock piston **360** and teeth form split grippers, e.g., **342** and **344**, as well as teeth engagement between teeth **38**, **138**, or **238** and **350**, result in transferring all of the load of plug piston **402** held by rear lid **300** and front lid **320** of mechanical lock unit **10**, **100**, **210**, **410**, which are very strong.

[0053] To unlock mechanical lock unit **10**, **100**, **210**, **410**, a hydraulic force is applied to spring-loaded lock piston **360** to overcome the force of biasing member **380** for pushing lock piston **360** into an unlocked position. When there is no applied force from lock piston **360**, teeth-form split grippers, e.g., **342** and **344**, of teeth form split gripper assembly **340** are lifted up by springs **346** between teeth form split grippers, e.g., **342** and **344**. Teeth engagement between split grippers **342**, **344** of teeth form split gripper assembly **340** and teeth form ring **30**, **130**, or **230** on shaft **14** is, therefore, removed and shaft **14** is unlocked and is free to move.

[0054] When mechanical lock **10**, **100**, **210**, **410** is used in pipeline isolation tools, packers **404** form a seal with a pipeline wall **415** (FIGS. 7, 8), which results in a pressure disparity across the seal, i.e., the seal of packers **404** creates a high pressure side H and a low pressure side L (FIG. 8). The higher pressure on high pressure side H results in forces that act on the isolation tool that push on the isolation tool from high pressure side H towards low pressure side L. Mechanical lock **10**, **100**, **210**, **410** locks only in one direction, i.e., mechanical lock 10, 100, 210, 410 locks the unset direction where the piston, comprised of shaft 14 and piston head 402 moves toward the low pressure side L and the plug cylinder 403 moves toward the high pressure side H, which prevents unset of packer **404**. A compression spring, e.g., resilient ring **50** (FIG. 2) or another spring member, is located adjacent to second end **34**, **134** of teeth-form ring **30**, **130**, **230**. When mechanical lock **10**, **100**, **210**, **410** is in a locked position (shown in Figure 8) and there is high isolation pressure in the pipeline on the high pressure side H that creates a large pressure differential across packers **404**, Compression spring **50** will be compressed to allow packers **404** to squeeze more (this is self-lock mode of the isolation tool). The self-lock mode increases the sealing capacity of the isolation tool under high isolation pressure. Thus, mechanical lock **10**, **100**, **210**, **410** in pipeline isolation locks shaft **14** in one direction, and does not lock shaft **14** in the other direction to let packers **404** squeeze more in self-lock mode when there is an isolation pressure in the pipeline.

[0055] In greater detail, when isolation plug **400** is set, shaft lock assembly **112**, **212** is locked, i.e., slips system **480** (FIG. 7) will grip the pipe and hold isolation plug **400** in place. Therefore, when set, structure connected to slip system **480**, e.g., shaft **14**, **114**, **214**, and plug piston, comprised of shaft 14 and piston head **402**, is held in place. Pressure from high pressure side H will push remaining components, including teeth form ring **30**, **130**, **230** and teeth form split gripper assembly **340**, towards low pressure side L, which forces packers **404** outwardly, i.e., increases the squeeze packers **404**. Mechanical lock is achieved by mechanical lock unit **10**, **100**, **210**, **410**, which holds teeth form ring **30**, **130**, **230**, when compression spring **50** is compressed. Compression of compression spring **50** results in an increase in the volume acting on the piston cylinder 403, i.e., (V_{set}), which lowers the set pressure. This is referred to as self-lock mode.

[0056] The amount of movement, i.e., the increase in squeeze of packer **404**, in self-lock mode depends on a difference between the force from isolation pressure and the original hydraulic set force, i.e., the pre-squeeze of the packer. Self-lock mode may be observed by a drop in the set pressure. At self-lock mode there will be a gap between first end **32**, **132** of teeth form ring **30**, **130**, **230**, **430** and first annular surface **20**, **120**, **220** of shaft **14**, **114**, **214** while second end **34**, **134** of teeth form ring **30**, **130**, **230** compresses compression spring **50**. In the embodiment shown in Figures 8 and 9, movement of the teeth form ring **30**, **130**, **230** leads to a drop of set pressure in self-lock mode. When the isolation pressure is removed, e.g., after an operation is complete, the set volume, V_{set}, will be restored to normal, which leads to restoration or increase in the set pressure. In self-lock mode, if set pressure is lost, e.g., due to a leak inside the hydraulic system or due to losing oil inside the set volume, V_{set}, the hydraulic lock will be lost. However, the isolation plug **400** will continue to seal since packer **404** will continue to be squeezed by isolation pressure. Therefore, self-lock mode increases the safety level of isolation plug **400** in operation. Additionally mechanical lock will remain as a safe guard to self-lock mode since mechanical lock is achieved by teeth engagement.

[0057] Thus, the present invention is well adapted to carry out the objectives and attain the ends and advantages mentioned above as well as those inherent therein. While presently preferred embodiments have been described for purposes of this disclosure, numerous changes and modifications will be apparent to those of ordinary skill in the art. Such changes and modifications are encompassed within the spirit of this invention as defined by the claims.

CLAIMS

What is claimed is:

1. A mechanical lock unit (10, 100, 210, 410) of a pipeline isolation tool comprising:

a teeth-form ring (30, 130, 230) for surrounding a shaft (14, 114, 214), said teeth-form ring (30, 130, 230) having a first end (32), a second end (34), a longitudinal axis, and an outer surface (36), said outer surface (36) defining a plurality of teeth (38, 138, 238) thereon;

a teeth-form split gripper assembly (340) surrounding said teeth-form ring (30, 130, 230), said teeth-form split gripper assembly (340) having at least a first teeth-form split gripper (342), a second teeth-form split gripper (344), and a spring between said first teeth-form split gripper and said second teeth-form split gripper for biasing said first teeth-form split gripper away from said second teeth-form split gripper, said first teeth-form split gripper (342) and said second teeth form split gripper (344) defining an inner surface (348), said inner surface (348) defining a plurality of teeth (350) for cooperative engagement with said plurality of teeth (38, 138, 238) of said teeth-form ring (30, 130, 230).

2. The mechanical lock unit (10, 100, 210, 410) according to claim 1 wherein:
said teeth-form ring (30, 130, 230) has a first part (140) and a second part (142) for facilitating installation on a shaft (14, 114, 214).

3. The mechanical lock unit (10, 100, 210, 410) according to claim 2 further comprising:
a connector (144//146) for joining said first part (140) and said second part (142) of said teeth-form ring (30, 130, 230).

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4. The mechanical lock unit (10, 100, 210, 410) according to claim 1 wherein:

said teeth-form ring (30, 130, 230) defines a slot (231) for receiving a bolt (215) for slidably retaining said teeth-form ring (30, 130, 230) on a shaft (14, 114, 214).

5. The mechanical lock unit (10, 100, 210, 410) according to claim 4 wherein said bolt (215) is threadably received in a threaded hole in said shaft (14, 114, 214).

6. The mechanical lock unit (10, 100, 210, 410) according to claim 1 wherein said plurality of teeth (38, 138, 238) on said teeth form ring (30, 130, 230) and said plurality of teeth (350) on said teeth form split gripper assembly (340) are parallel for allowing full rotation of said teeth-form split gripper assembly (340) with respect to said teeth-form ring (30, 130, 230) without losing engagement.

7. The mechanical lock unit (10, 100, 210, 410) according to claim 1 wherein:

said teeth-form split gripper assembly (340) has an outer surface (352) that defines at least one ramp (354); and further comprising

a lock piston (360) located for sliding parallel to said longitudinal axis, said lock piston (360) having a ramped portion (366) defining an inside surface for selective engagement with said at least one ramp (354) on said outer surface of said teeth-form split gripper assembly (340) for selectively pressing said teeth-form split gripper assembly (340) into contact with said teeth-form ring (30, 130, 230).

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8. A pipeline isolation tool comprising:

a shaft (14, 114, 414) having a plug cylinder (402) affixed thereto;

a packer (404) activated by hydraulic pressure used to move said plug cylinder (402) and said shaft (14, 114, 414);

a mechanical lock unit (10, 100, 210, 410) for securing a position of said shaft (14, 114, 414), said mechanical lock unit (10, 100, 210, 410) comprising a teeth-form ring (30, 130, 230) for surrounding said shaft (14, 114, 214), said teeth-form ring (30, 130, 230) having a first end (132), a second end (134), a longitudinal axis, and an outer surface (136), said outer surface (136) defining a plurality of teeth (38, 138, 238) thereon;

a teeth-form split gripper assembly (340) surrounding said teeth-form ring (30, 130, 230), said teeth-form split gripper assembly (340) having at least a first teeth-form split gripper (342), a second teeth-form split gripper (344), and a spring between said first teeth-form split gripper and said second teeth-form split gripper for biasing said first teeth-form split gripper away from said second teeth-form split gripper;

said first teeth-form split gripper (342) and said second teeth form split gripper (344) defining an inner surface (348), said inner surface (348) defining a plurality of teeth (350) for cooperative engagement with said plurality of teeth (38, 138, 238) of said teeth-form ring (30, 130, 230).

9. The pipeline isolation tool according to claim 8 wherein:

said teeth-form ring (30, 130, 230) has a first part (140) and a second part (142) for facilitating installation on said shaft (14, 114, 214).

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10. The pipeline isolation tool according to claim 9 further comprising:

a connector (144/146) for joining said first part (140) and said second part (142) of said teeth-form ring (30, 130, 230).

11. The pipeline isolation tool according to claim 8 wherein:

said teeth-form ring (30, 130, 230) defines a slot (231) for receiving a guide pin (215) for slidably retaining said teeth-form ring (30, 130, 230) on a shaft for limiting axial travel of said teeth-form ring (30, 130, 230) on the shaft (14, 114, 214).

12. The pipeline isolation tool according to claim 8 wherein said plurality of teeth (38, 138, 238) on said teeth form ring (30, 130, 230) and said plurality of teeth (350) on said teeth form split gripper assembly (340) are parallel for allowing full rotation of said teeth-form split gripper assembly (340) with respect to said teeth-form ring (30, 130, 230) without losing engagement.

13. The pipeline isolation tool according to claim 8 wherein:

said teeth-form split gripper assembly (340) has an outer surface (352) that defines at least one ramp (354); and further comprising

a lock piston (360) located for sliding parallel to said longitudinal axis, said lock piston (360) having a ramped portion (366) defining an inside surface for selective engagement with said at least one ramp (354) on said outer surface (352) of said teeth-form split gripper assembly (340) for selectively pressing said teeth-form split gripper assembly (340) into contact with said a teeth-form ring (30, 130, 230).

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14. A method of securing a pipeline isolation tool in a pipeline comprising:

moving a piston (402) for actuating the isolation tool, said piston (42) affixed to a shaft (14, 114, 214);

extending a slip assembly (480) to engage a wall of the pipeline;

extending a packer (404) to engage the wall of the pipeline for creating a high pressure on a high pressure side of the isolation tool and a low pressure on a low pressure side of the isolation tool;

engaging said shaft (14, 114, 214) with a mechanical lock (10, 100, 210, 410), the mechanical lock including a teeth-form ring for surrounding said shaft and a tooth-form split gripper assembly surrounding said teeth-form ring;

compressing a compression spring (50) with said high pressure by moving said cylinder (402) towards said low pressure side;

wherein said moving of said cylinder increases a set volume, which lowers a set pressure for effecting a self-lock mode.

15. The method according to claim 14 wherein:

said teeth-form ring (30, 130, 230) having a first end (132), a second end (134), a longitudinal axis, and an outer surface, (136) said outer surface (136) defining a plurality of teeth (38, 138, 238) thereon;

said teeth-form split gripper assembly (340) having at least a first teeth-form split gripper (342) and a second teeth-form split gripper (344), said first teeth-form split gripper (342) and said

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second teeth form split gripper (344) defining an inner surface (348), said inner surface (348) defining a plurality of teeth (350) for cooperative engagement with said plurality of teeth (38, 138, 238) of said teeth-form ring (30, 130, 230).

16. The method according to claim 15, wherein the mechanical lock further comprises:

a spring between said first teeth-form split gripper and said second teeth-form split gripper for biasing said first teeth-form split gripper away from said second teeth-form split gripper.

17. The method according to claim 15, wherein:

said teeth-form split gripper assembly has an outer surface that defines at least one ramp; and

wherein the mechanical lock unit further comprises:

a lock piston located for sliding parallel to said longitudinal axis, said lock piston having a ramped portion defining an inside surface for selective engagement with said at least one ramp on said outer surface of said teeth-form split gripper assembly for selectively pressing said teeth-form split gripper assembly into contact with said teeth-form ring.

18. The method according to claim 17, wherein:

the outer surface of the teeth-form gripper assembly includes a flat run adjacent to the at least one ramp; and

the inside surface of the lock piston includes a corresponding flat run portion adjacent to the ramped portion.

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19. The method according to claim 15, wherein said teeth-form ring defines a slot for receiving a bolt for slidably retaining said teeth-form ring on a shaft.

20. The mechanical lock unit of claim 1, further comprising, said teeth-form ring defines a slot for receiving a bolt for slidably retaining said teeth-form ring on a shaft.

21. The mechanical lock unit of claim 20 wherein said bolt is threadably received in a threaded hole in said shaft.

22. The pipeline isolation tool of claim 8, further comprising, said teeth-form ring defines a slot for receiving a bolt for slidably retaining said teeth-form ring on the shaft.

23. The pipeline isolation tool of claim 22, wherein said bolt is threadably received in a threaded hole in said shaft.

24. A mechanical lock unit of a pipeline isolation tool comprising:

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a teeth-form ring for surrounding a shaft, said teeth-form ring having a first end, a second end, a longitudinal axis, and an outer surface, said outer surface defining a plurality of teeth thereon;

a teeth-form split gripper assembly surrounding said teeth-form ring, said teeth-form split gripper assembly having at least a first teeth-form split gripper and a second teeth-form split gripper, said first teeth-form split gripper and said second teeth form split gripper defining an inner surface, said inner surface defining a plurality of teeth for cooperative engagement with said plurality of teeth of said teeth-form ring;

said teeth-form ring defines a slot for receiving a bolt for slidably retaining said teeth-form ring on a shaft.

25. The mechanical lock unit of claim 24, wherein said teeth-form ring has a first part and a second part for facilitating installation on a shaft.

26. The mechanical lock unit of claim 24, further comprising a connector for joining said first part and said second part of said teeth-form ring.

27. The mechanical lock unit of claim 24, wherein said bolt is threadably received in a threaded hole in said shaft.

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28. The mechanical lock unit according to claim 24 further comprising a spring between said first teeth-form split gripper and said second teeth-form split gripper for biasing said first teeth-form split gripper away from said second teeth-form split gripper.

29. The mechanical lock unit of claim 24, wherein said plurality of teeth on said teeth form ring and said plurality of teeth on said teeth form split gripper assembly are parallel for allowing full rotation of said teeth-form split gripper assembly with respect to said teeth-form ring without losing engagement.

30. The mechanical lock unit of claim 24 wherein:

said teeth-form split gripper assembly has an outer surface that defines at least one ramp; and further comprising

a lock piston located for sliding parallel to said longitudinal axis, said lock piston having a ramped portion defining an inside surface for selective engagement with said at least one ramp on said outer surface of said teeth-form split gripper assembly for selectively pressing said teeth-form split gripper assembly into contact with said a teeth-form ring.

31. The mechanical lock unit of claim 30, wherein, the outer surface of the teeth-form gripper assembly includes a flat run adjacent to the at least one ramp; and

the inside surface of the lock piston includes a corresponding flat run portion adjacent to the at least one ramp.

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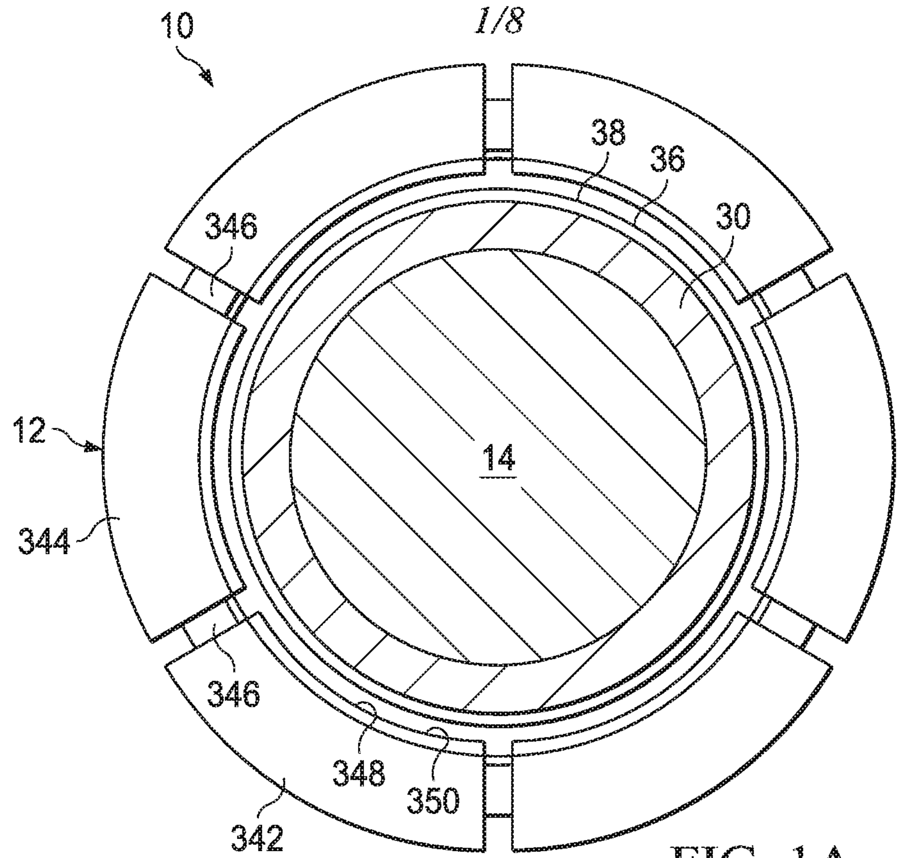
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350
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FIG. 1A

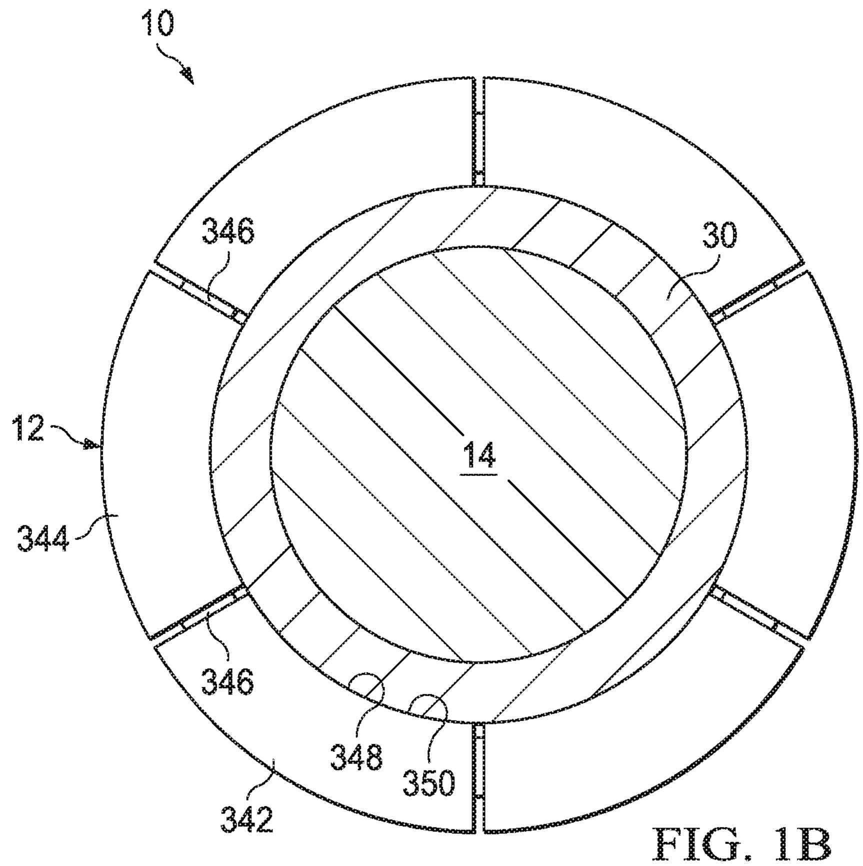
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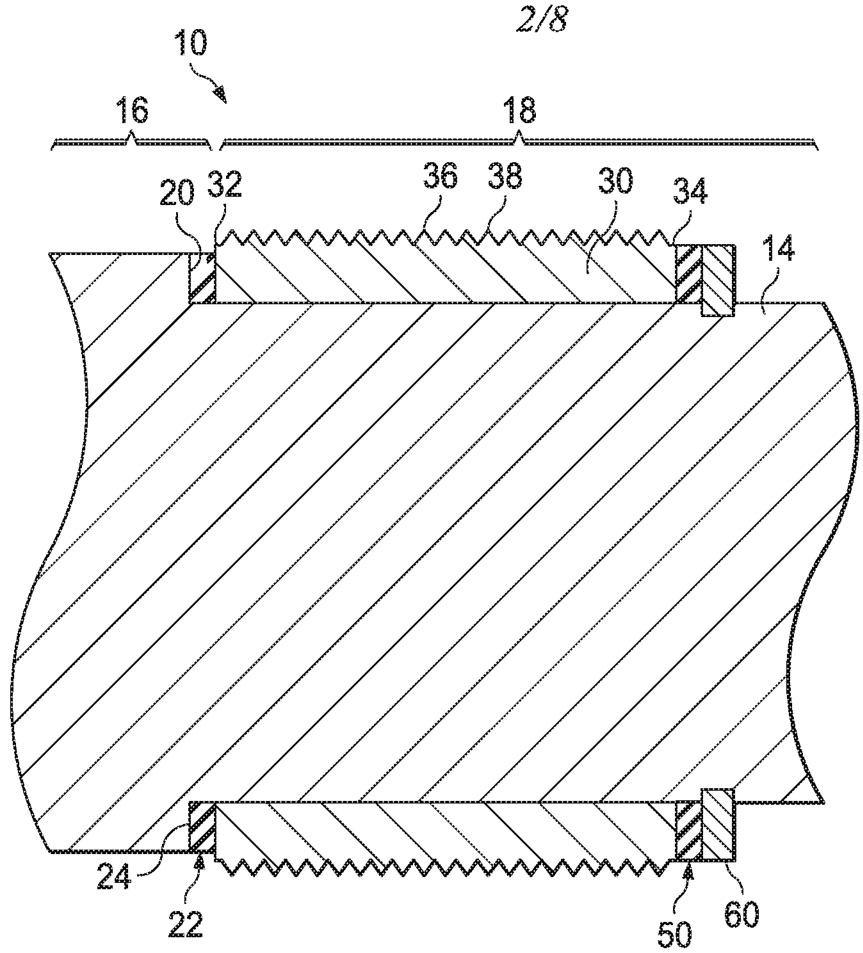
FIG. 1B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60

FIG. 2

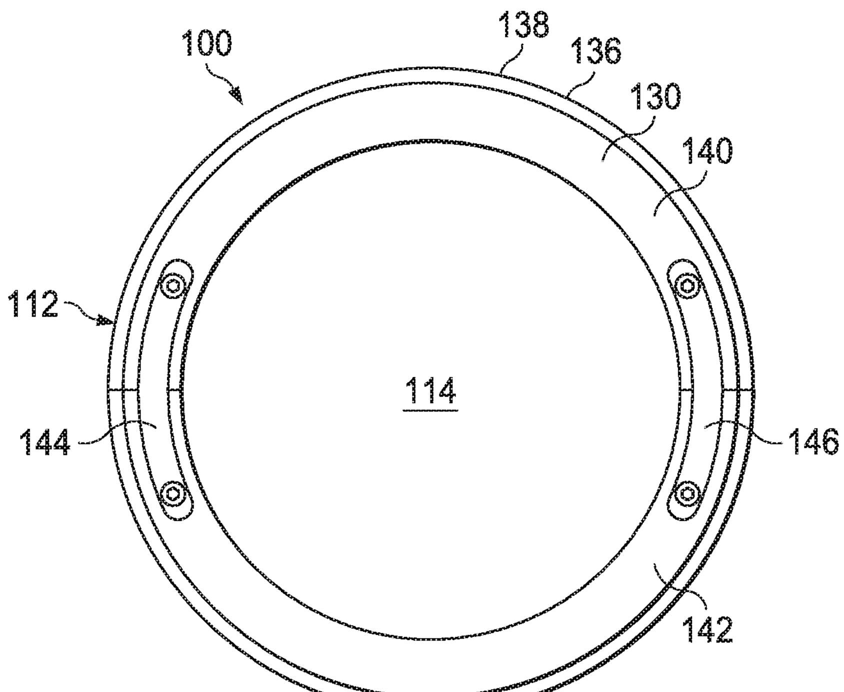
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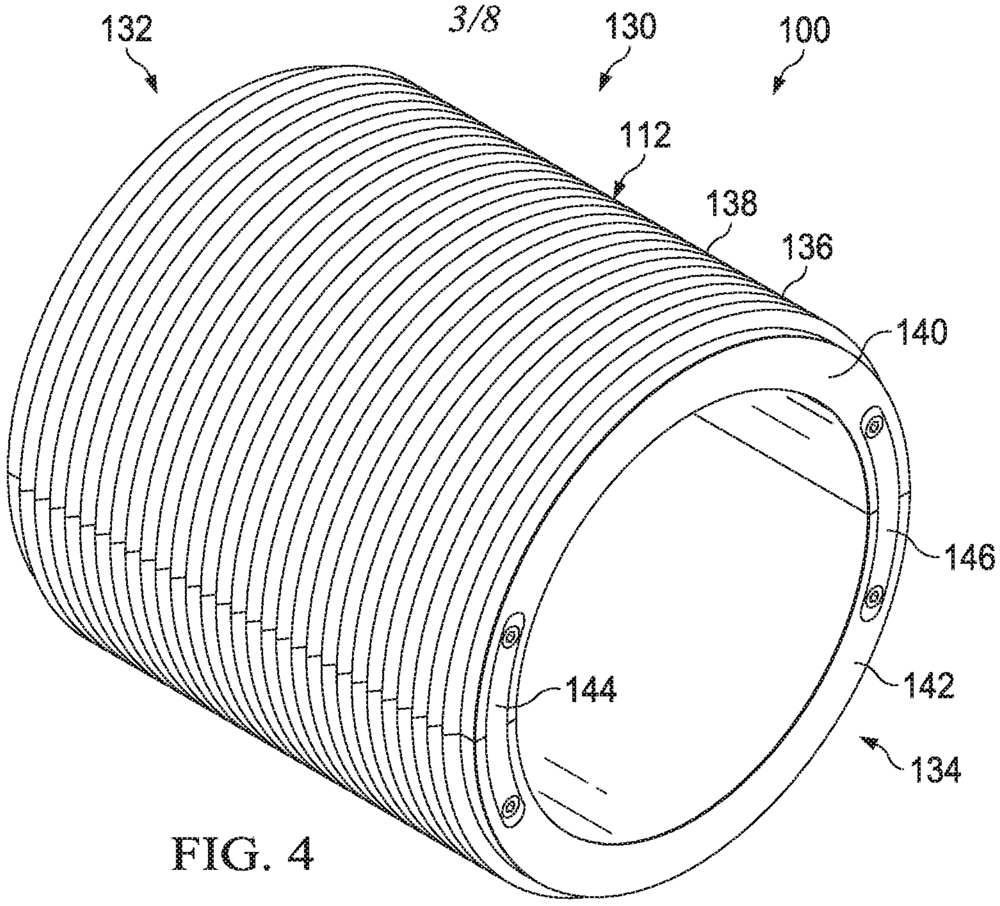
FIG. 3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134

FIG. 4

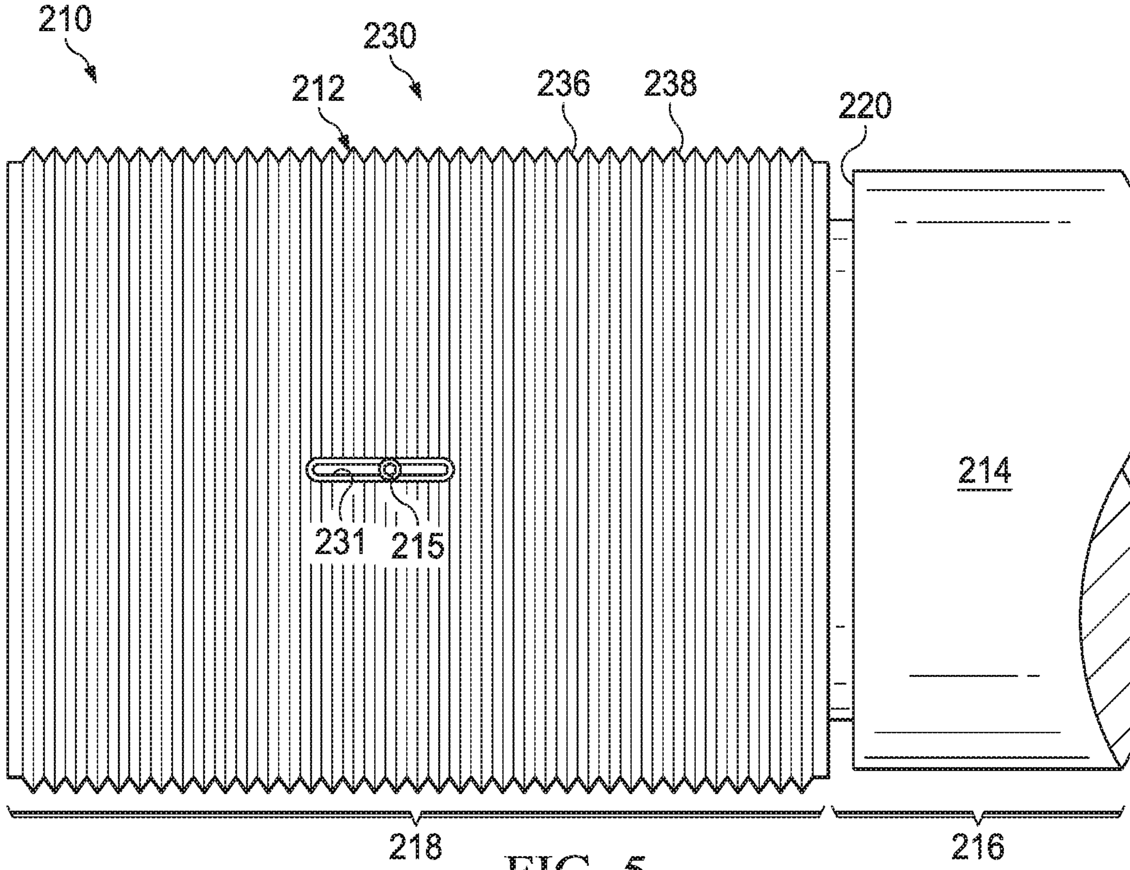
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FIG. 5

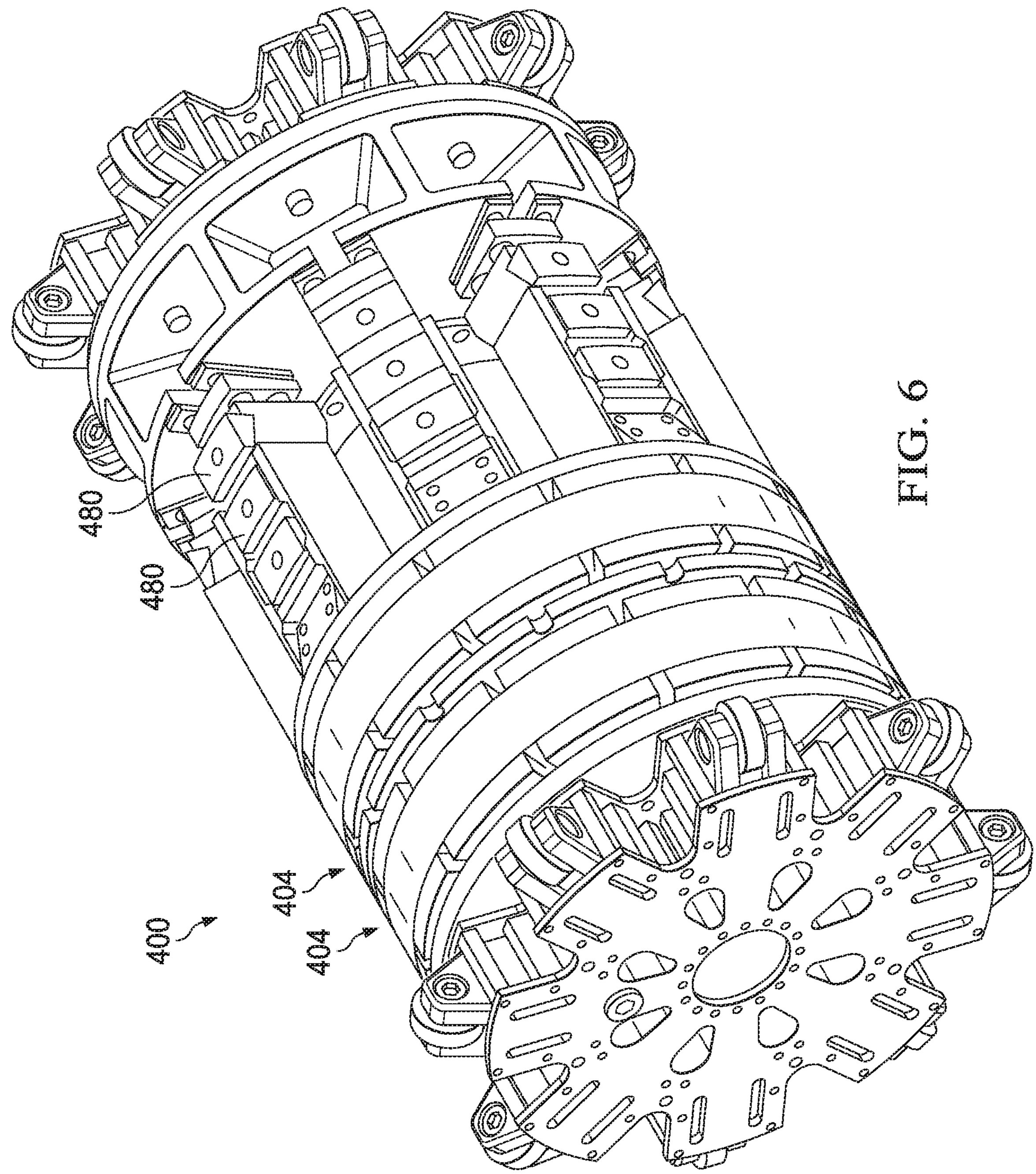

FIG. 6

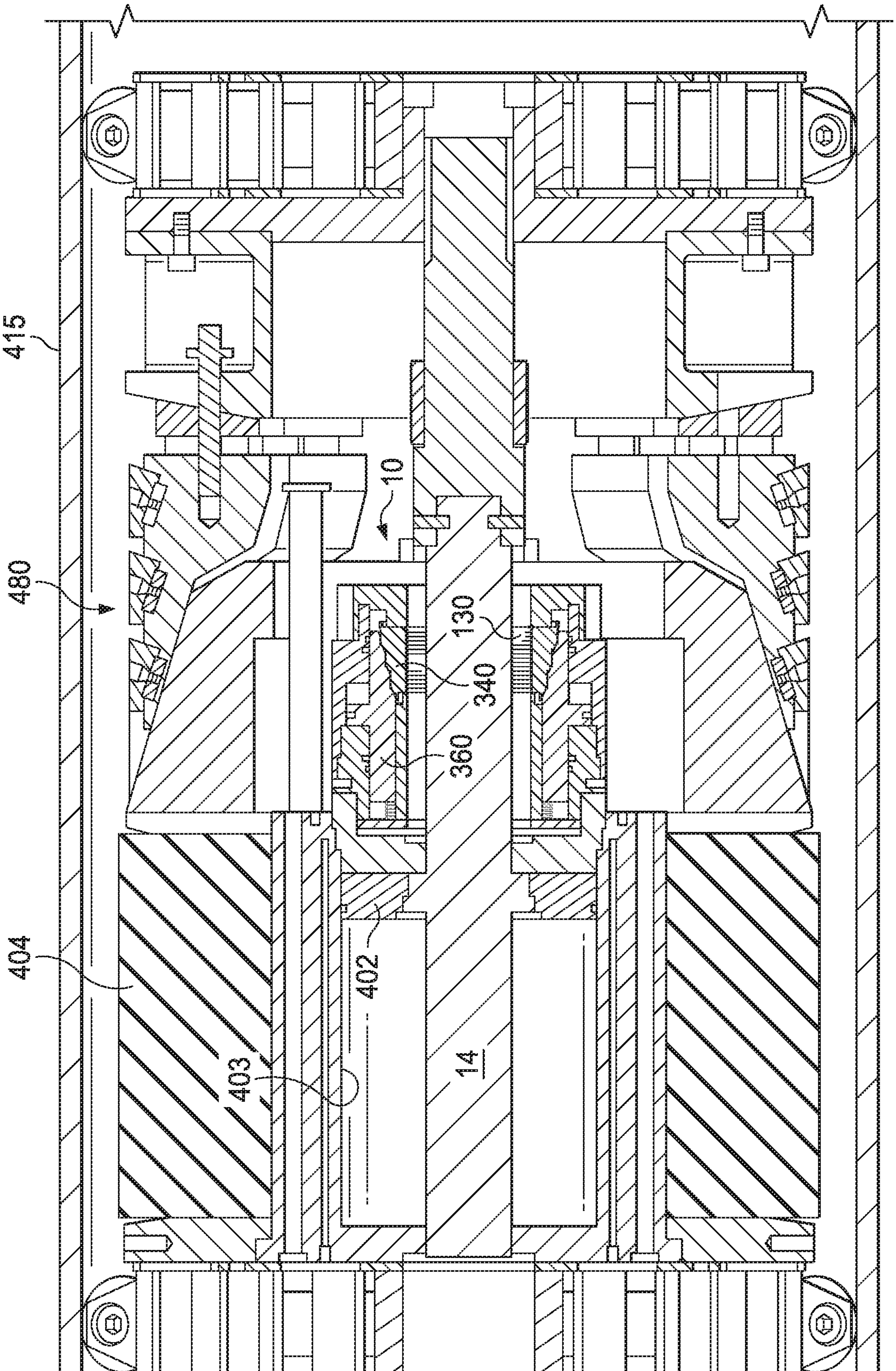

FIG. 7

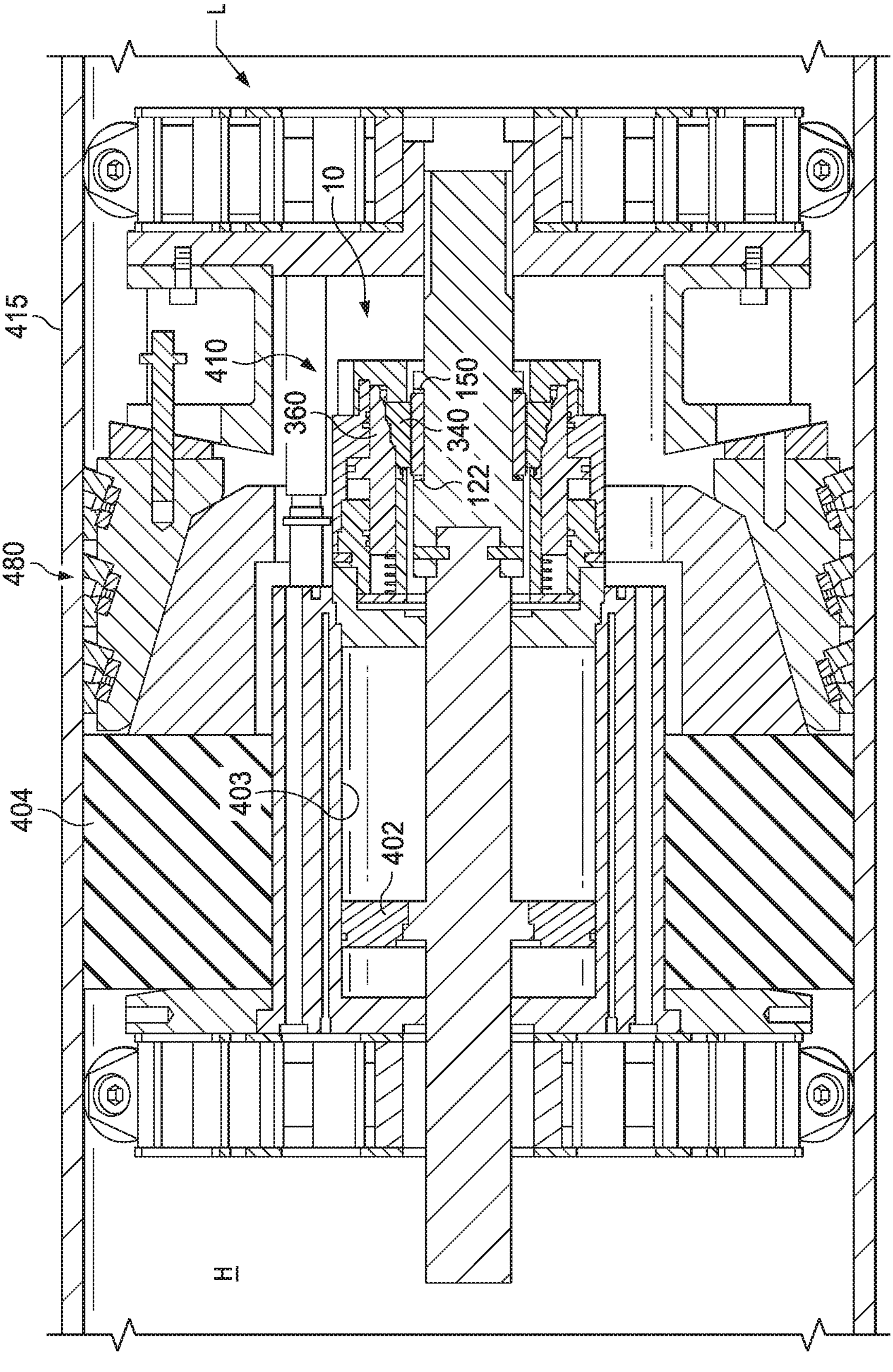

FIG. 8

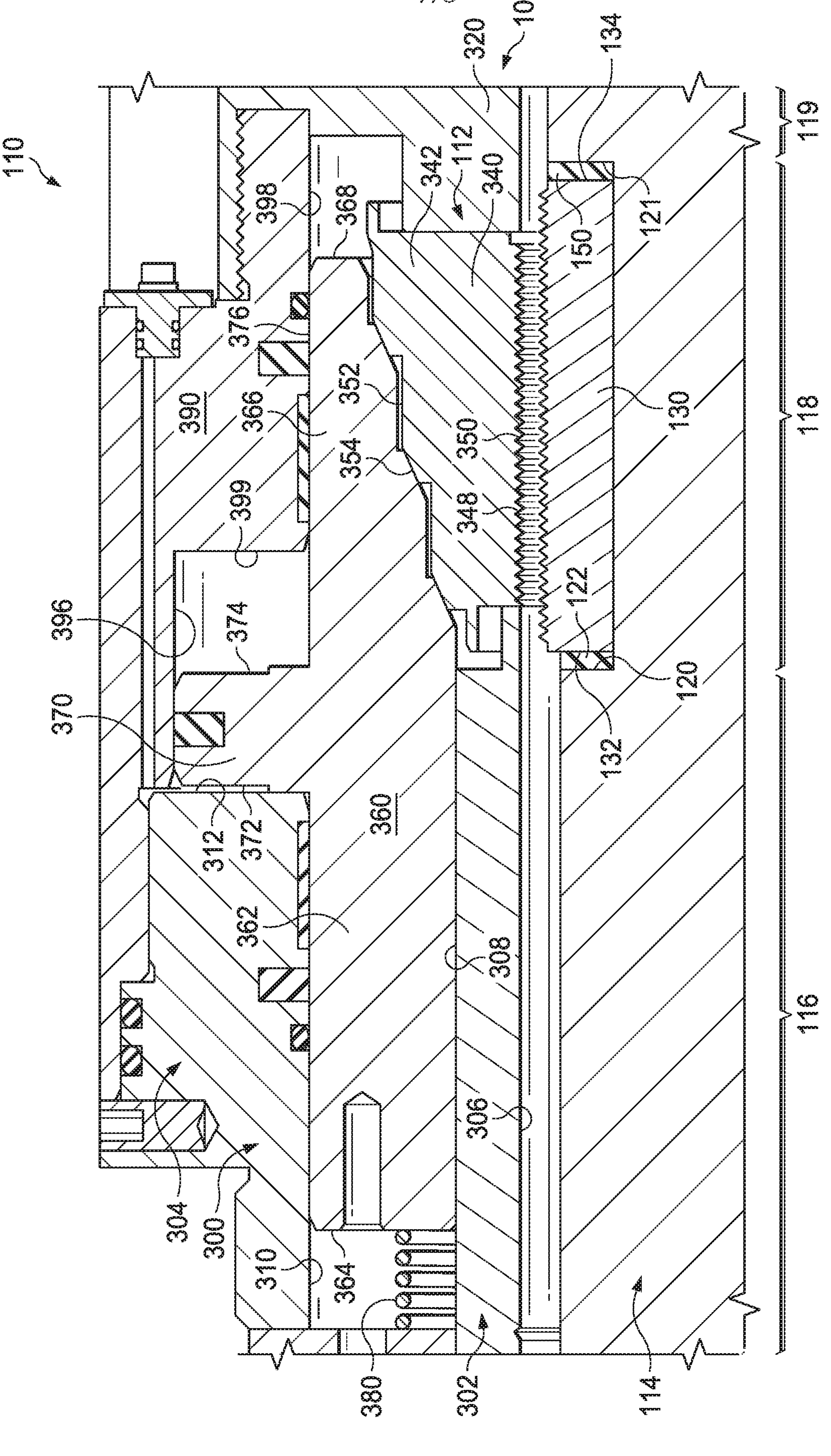
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FIG. 9

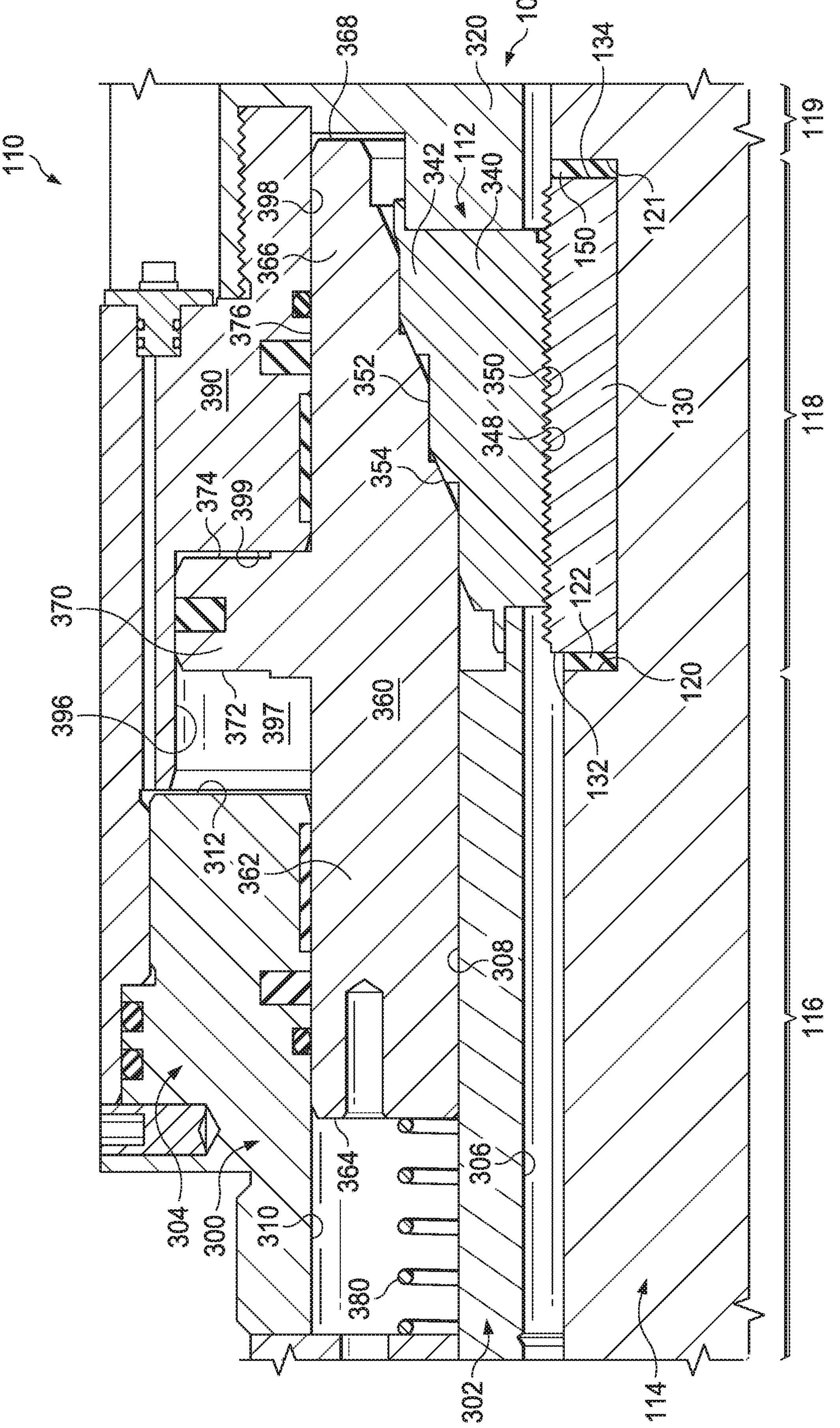
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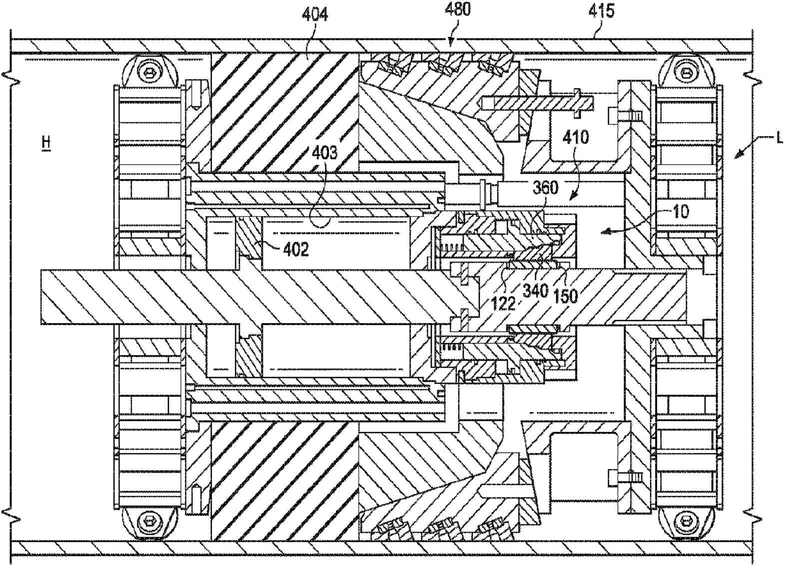
FIG. 10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