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Skrjanc et al.

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(54) **TOOL-LESS CLUTCH ADJUSTMENT AND REMOVAL FOR DRAIN CLEANER**

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(51) **Int. Cl.**

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F16D 13/62	(2006.01)
F16D 23/12	(2006.01)
F16D 13/75	(2006.01)
F16H 1/16	(2006.01)
B08B 9/04	(2006.01)
F16H 19/04	(2006.01)
B08B 9/045	(2006.01)

(52) **U.S. Cl.**

CPC ***F16D 13/10*** (2013.01); ***B08B 9/04*** (2013.01); ***F16D 13/62*** (2013.01); ***F16D 13/75*** (2013.01); ***F16D 23/12*** (2013.01); ***F16H 1/16*** (2013.01); ***F16H 19/04*** (2013.01); *B08B 9/045* (2013.01); *F16D 2023/123* (2013.01)

(58) **Field of Classification Search**

CPC F16D 13/62; F16D 13/10

See application file for complete search history.

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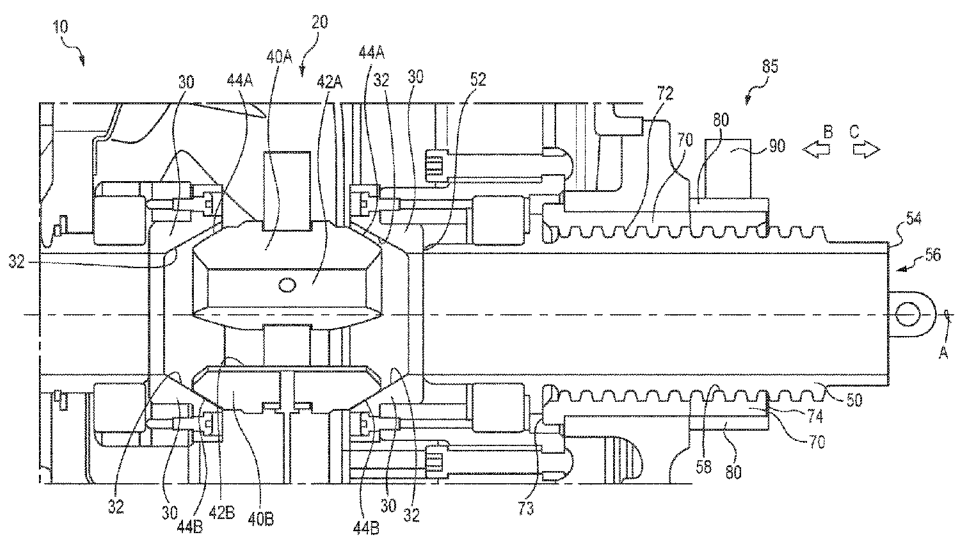
(57) **ABSTRACT**

Various clutch adjusting assemblies for incorporating in drain cleaning machines are described. The assemblies enable adjustment or setting of a clutch in a drain cleaning machine without the use of tools.

7 Claims, 24 Drawing Sheets



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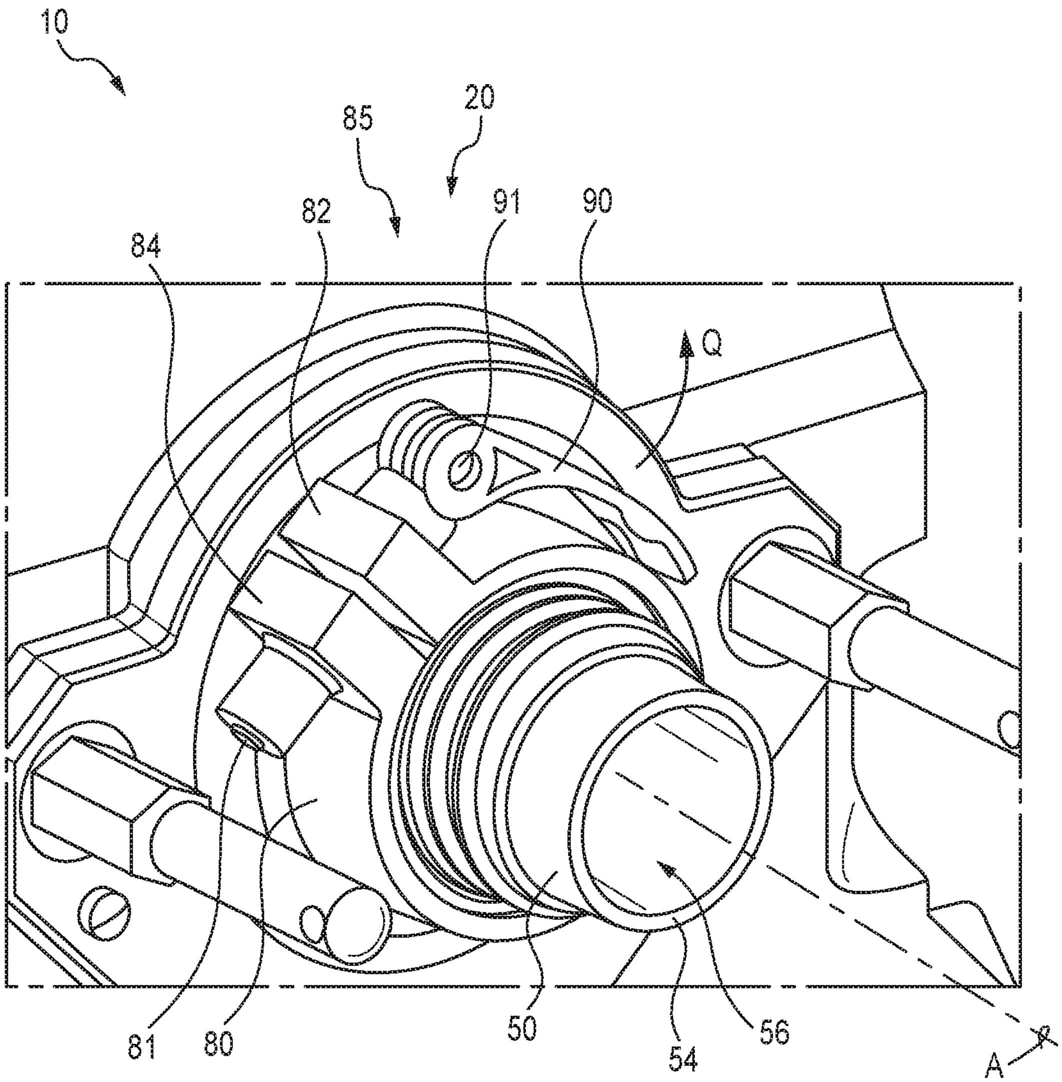
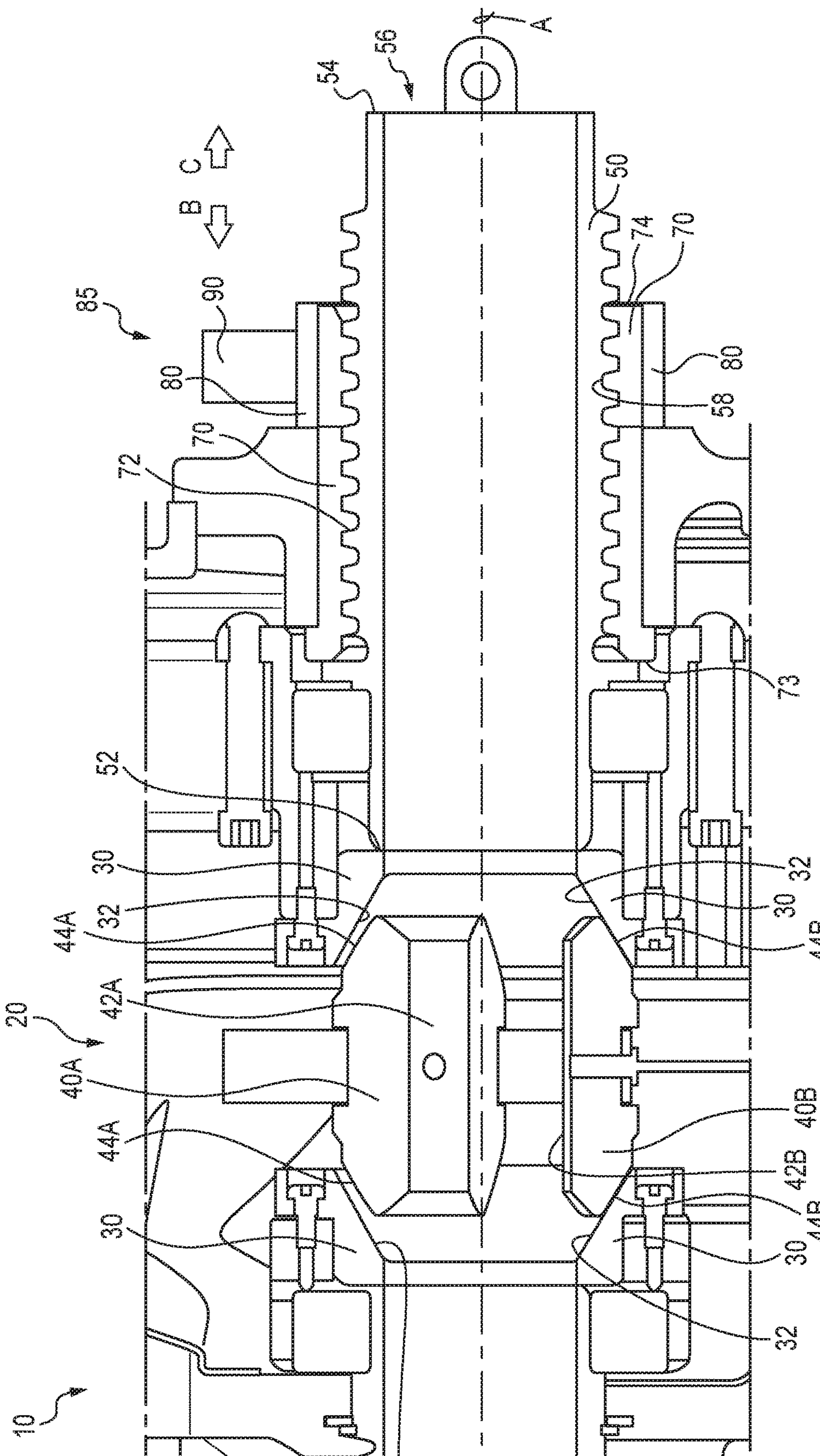


FIG. 1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42B
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FIG. 2

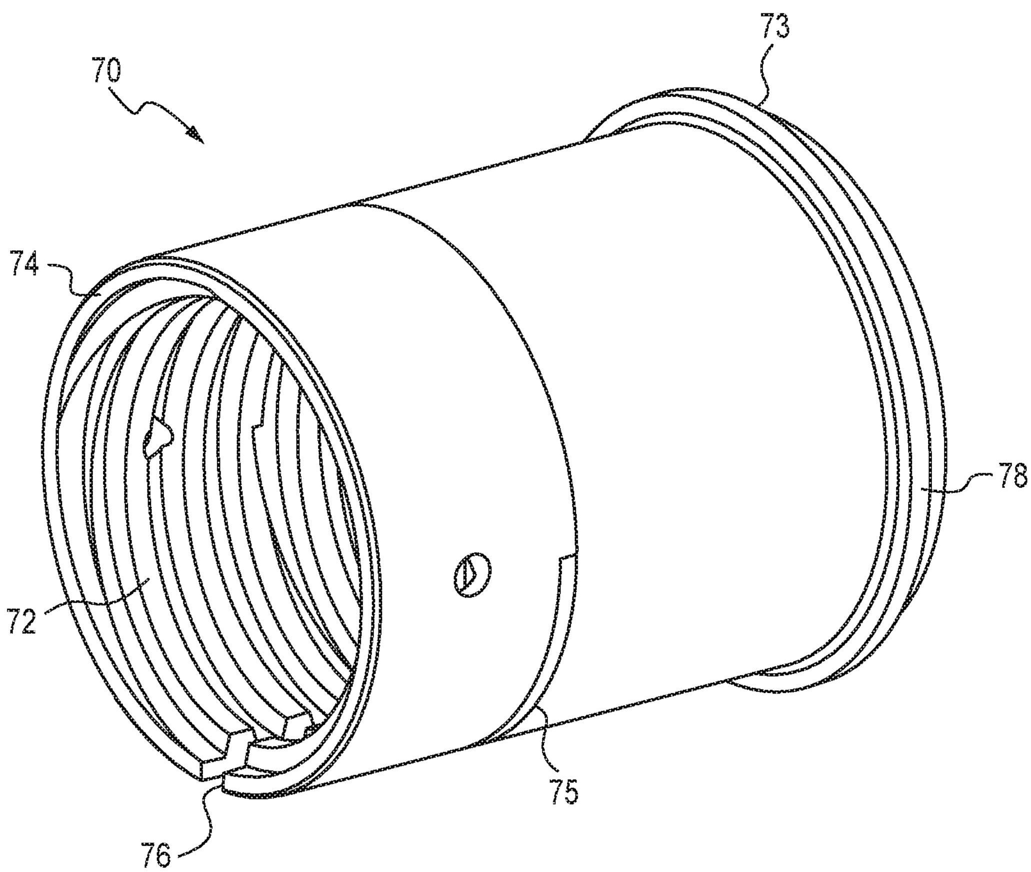


FIG. 3

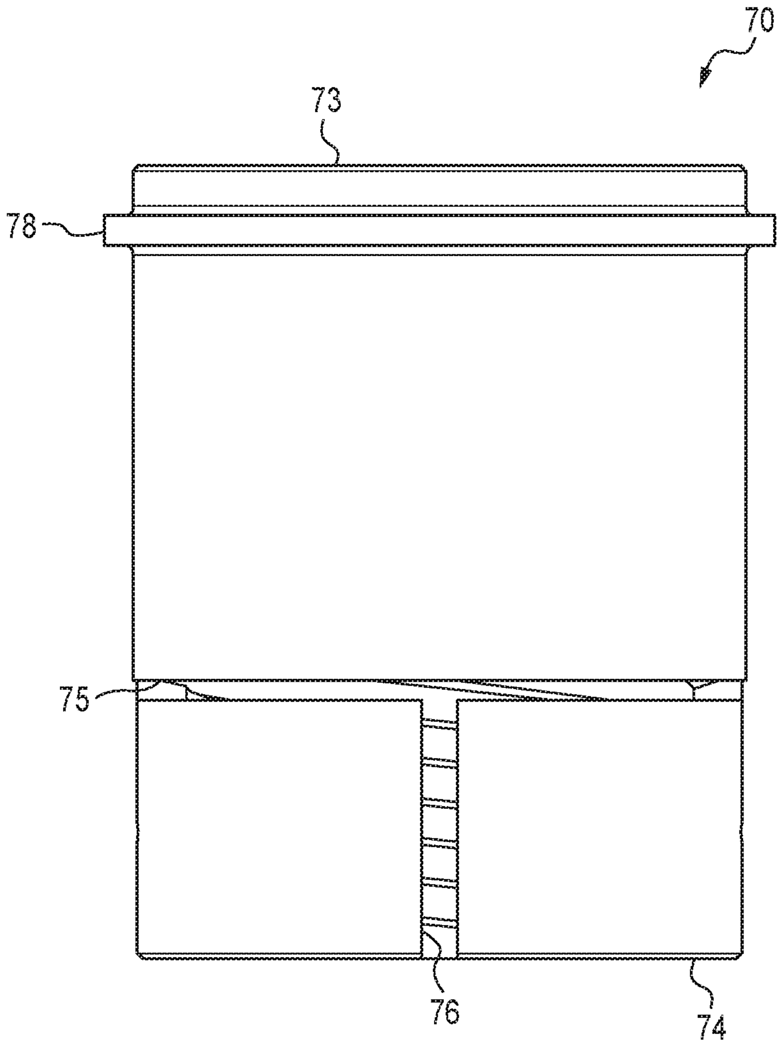


FIG. 4

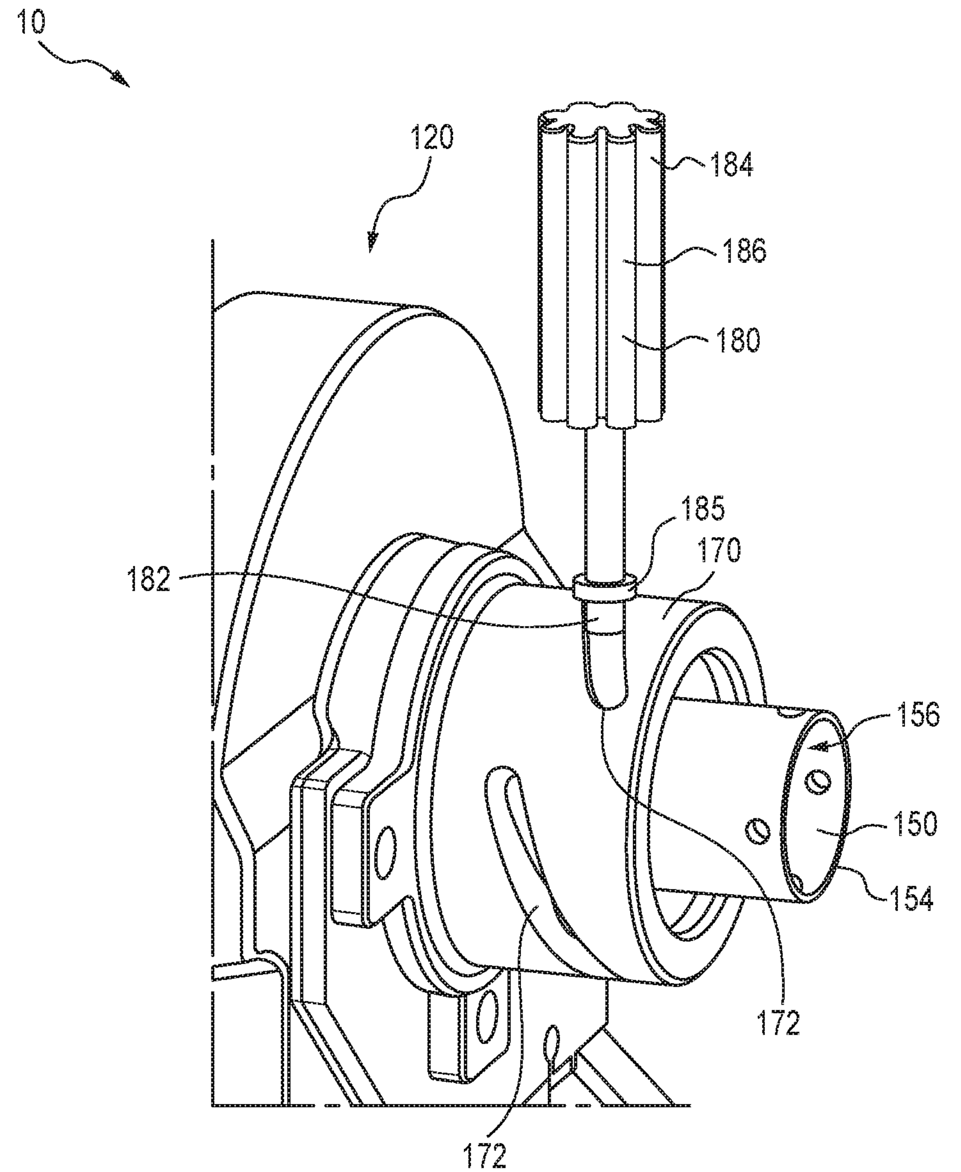


FIG. 5

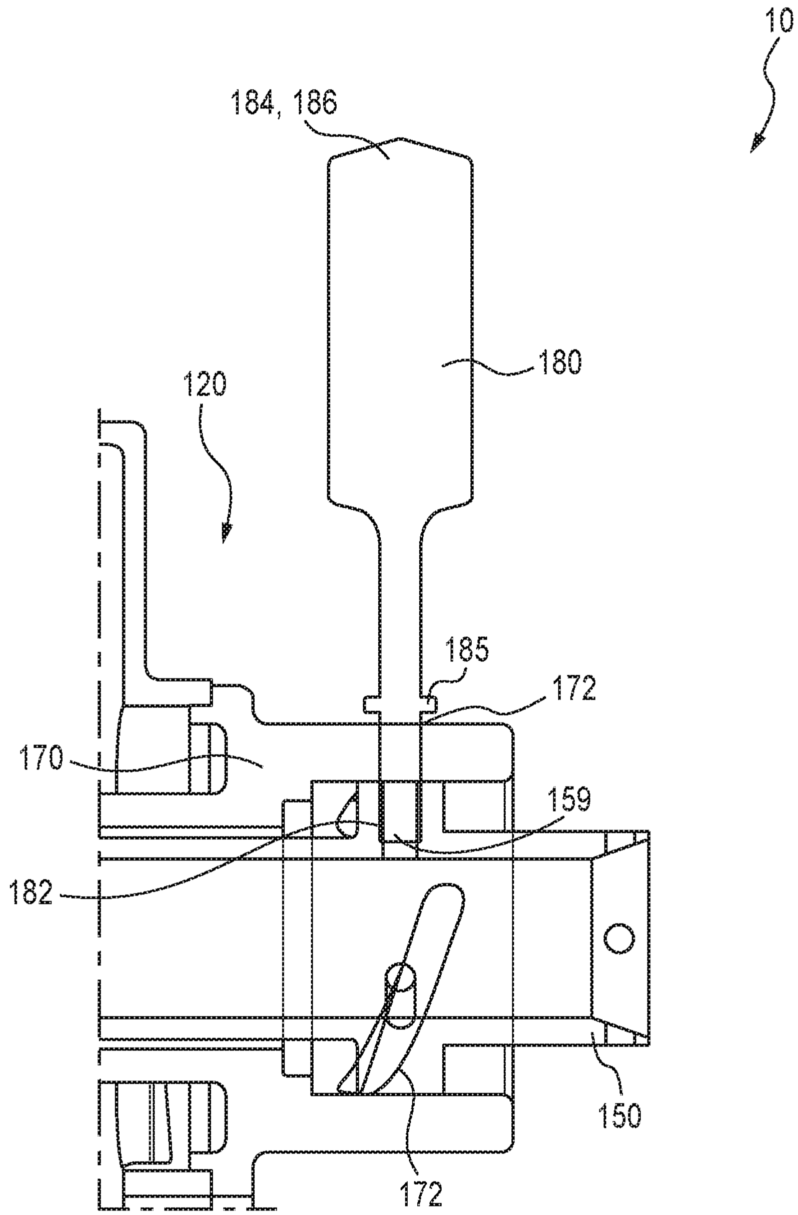


FIG. 6

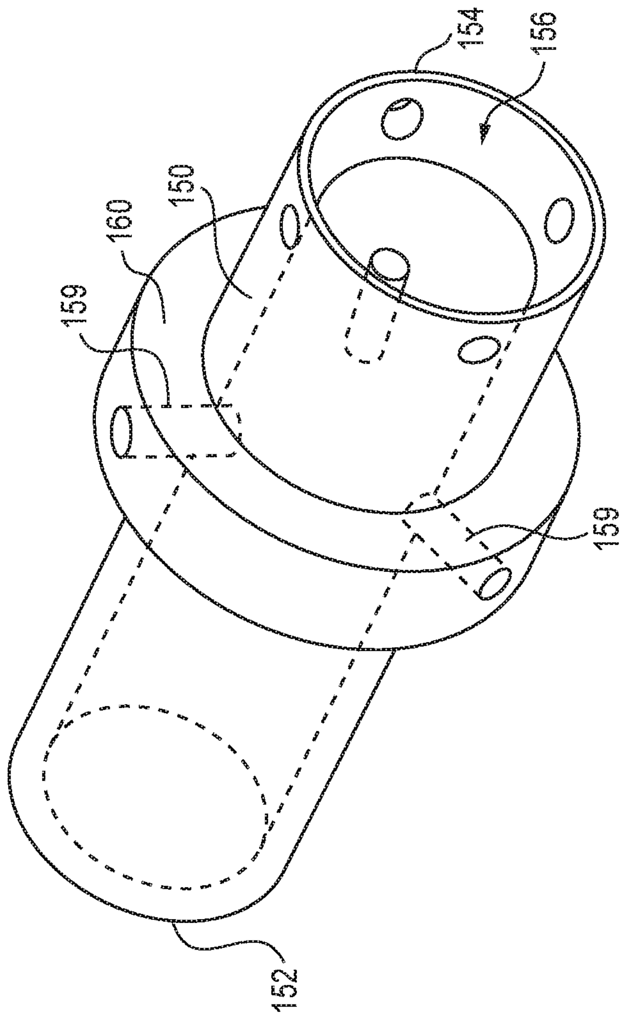


FIG. 8

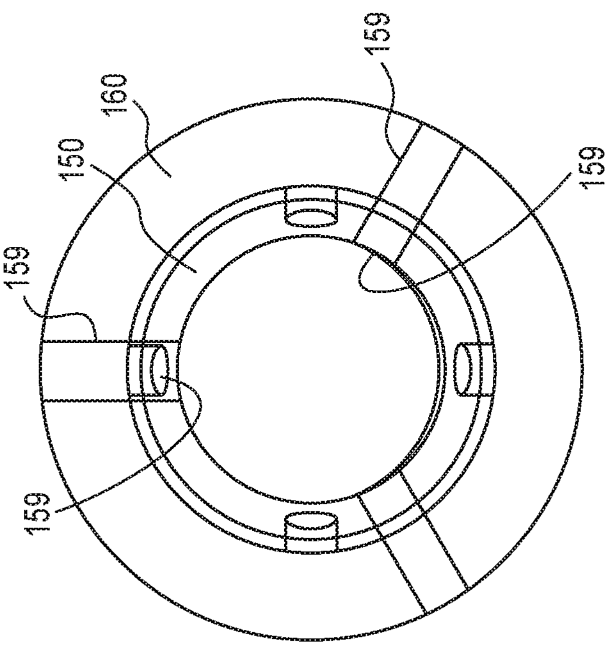


FIG. 7

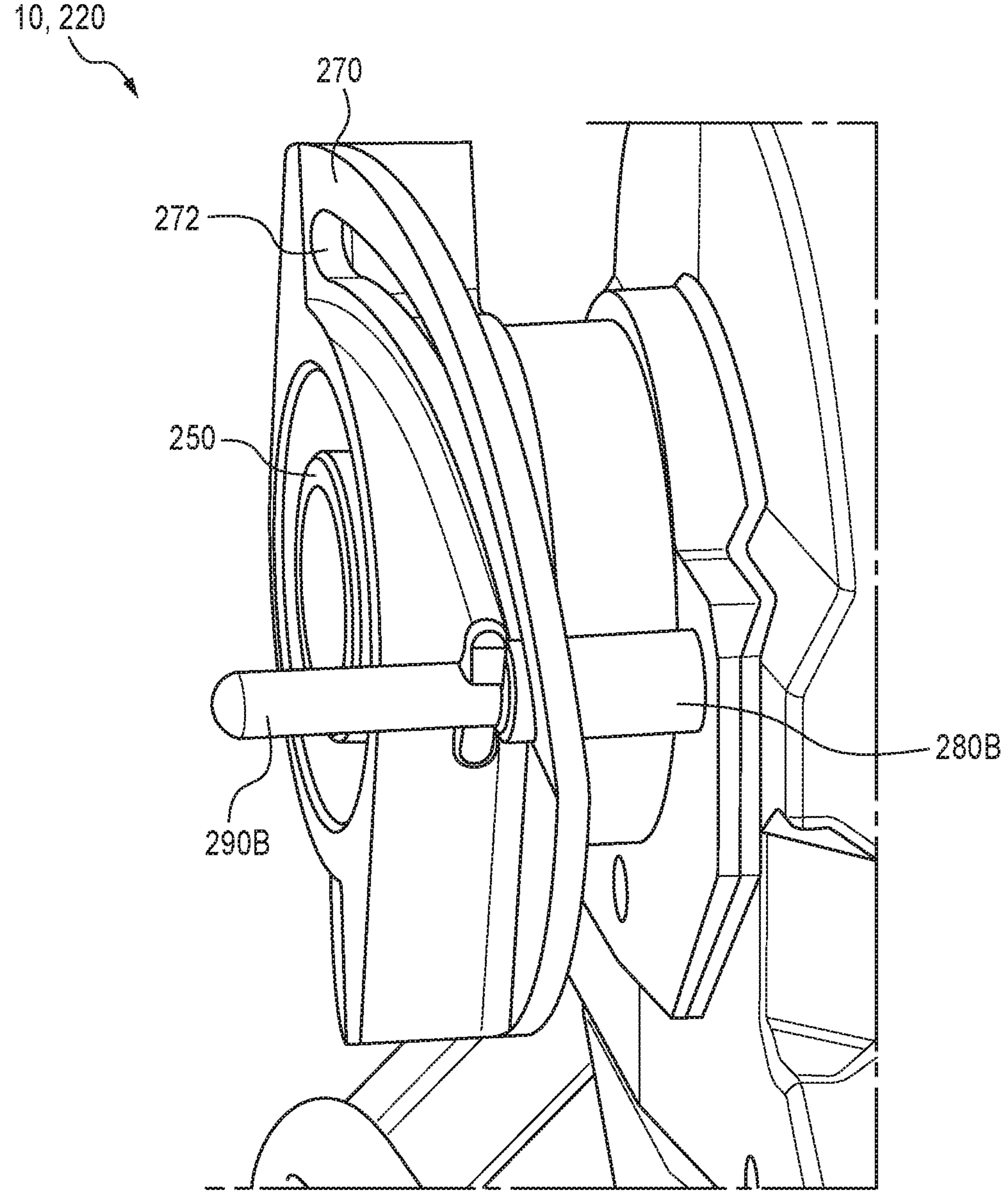


FIG. 9

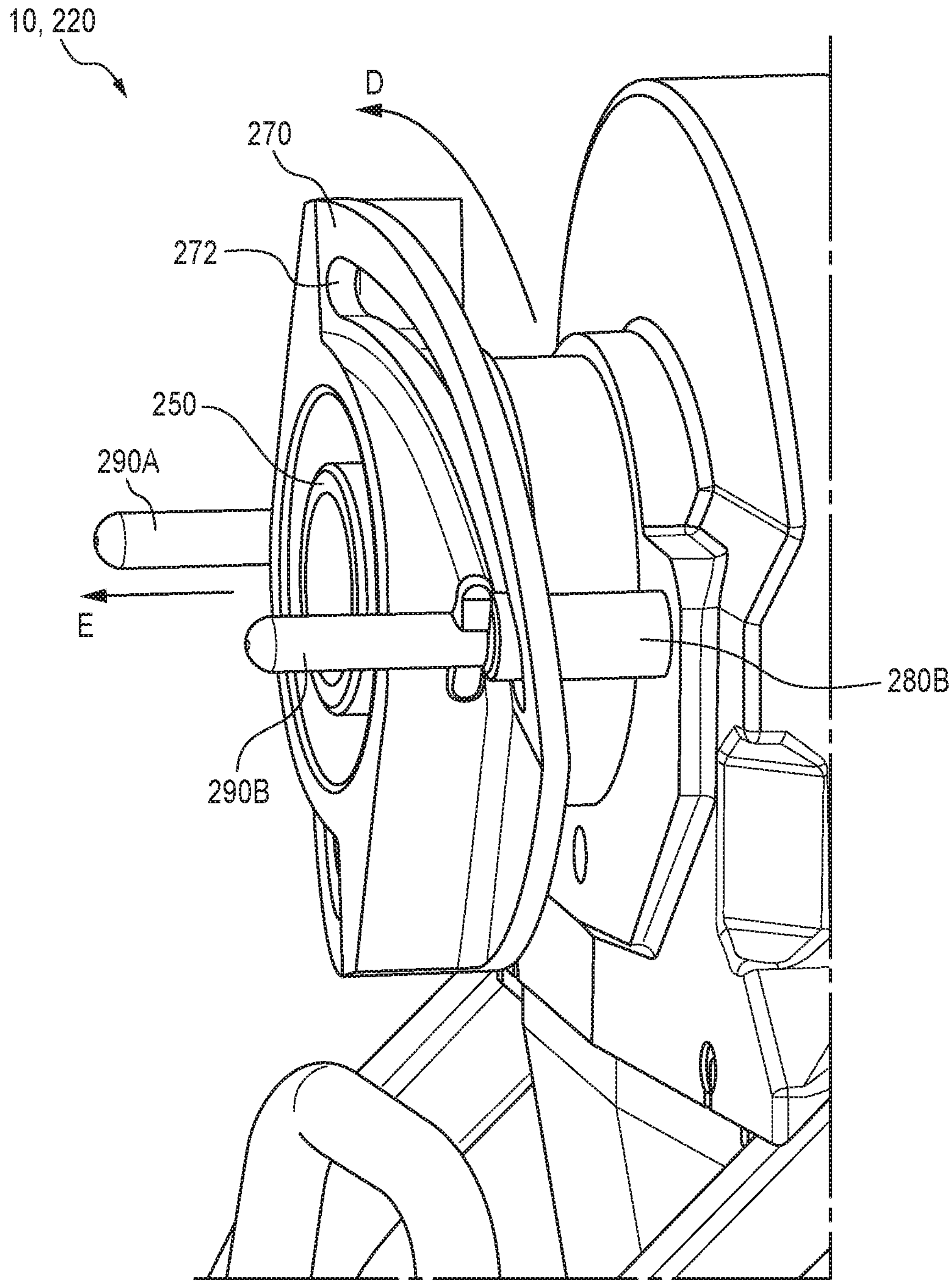


FIG. 10

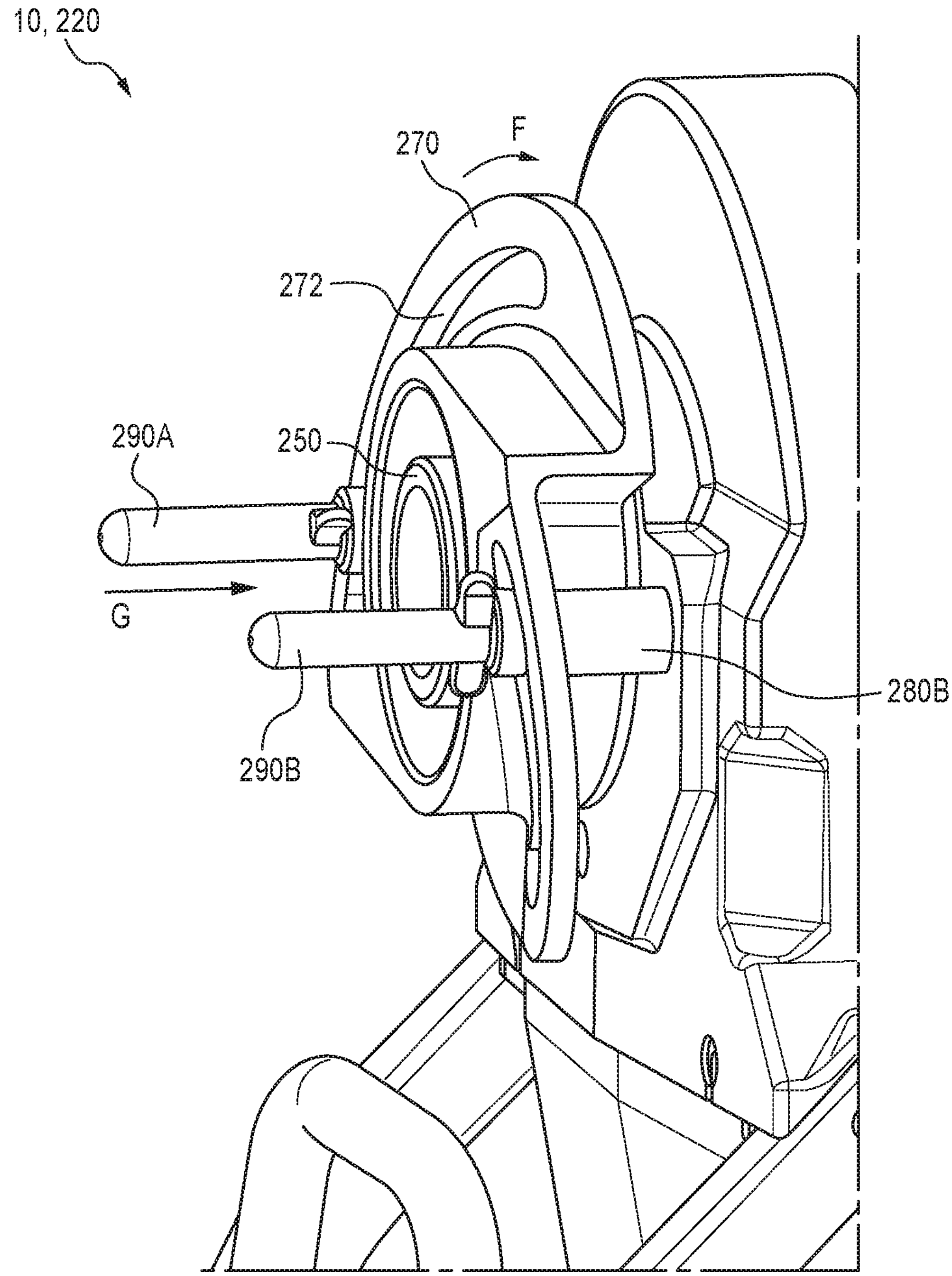
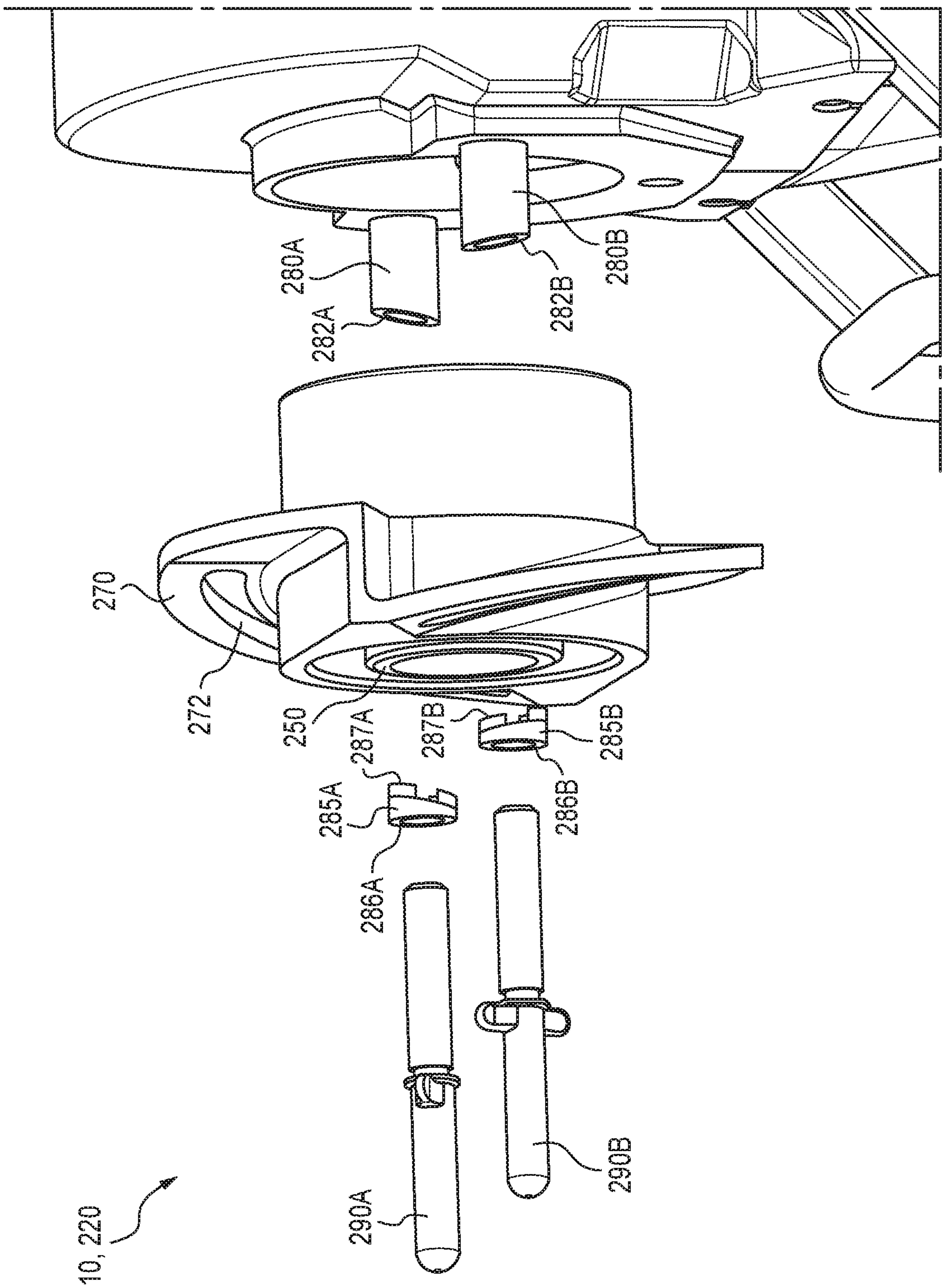


FIG. 11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282A
280A
282B
280B

FIG. 12

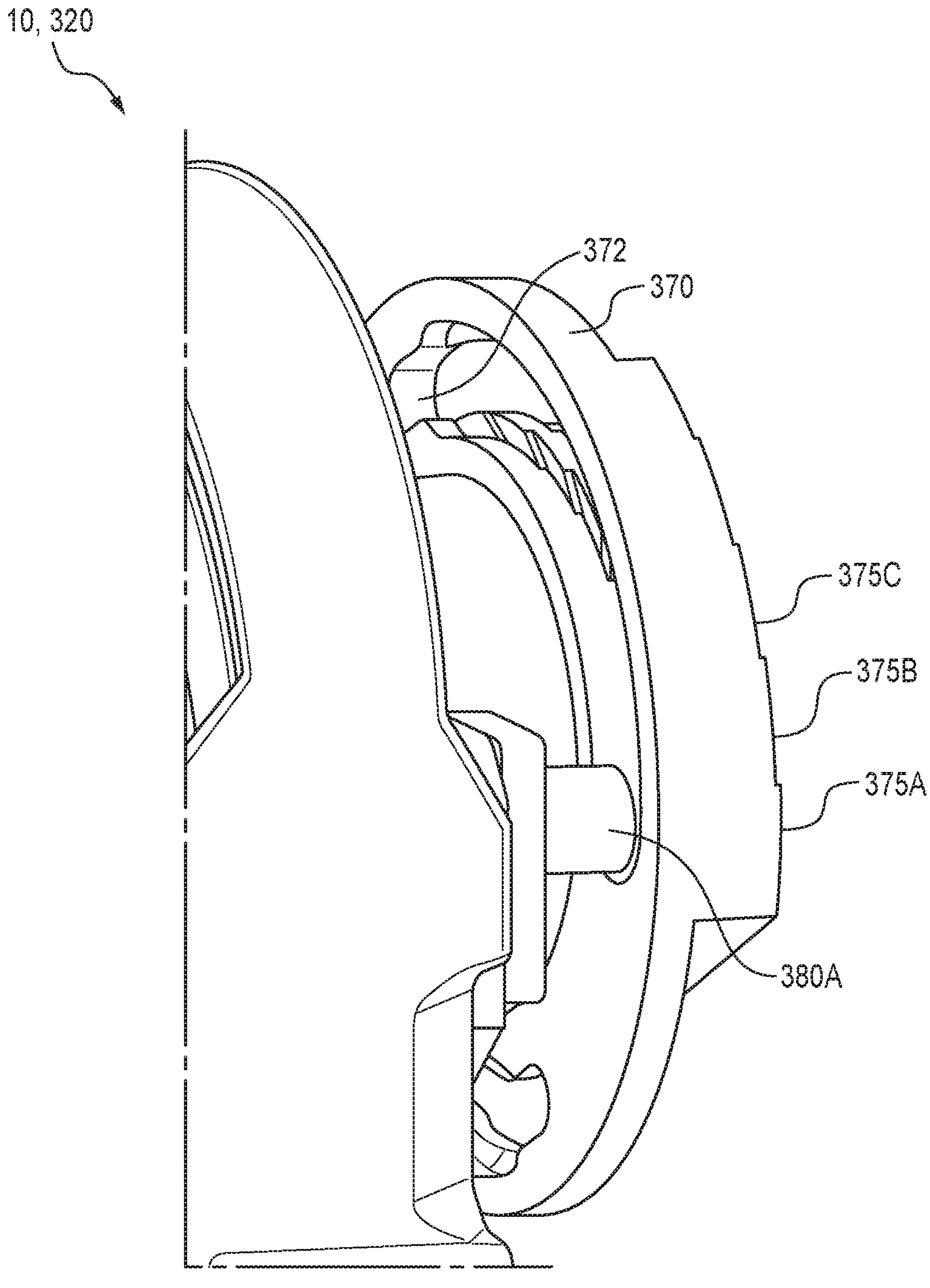

FIG. 13

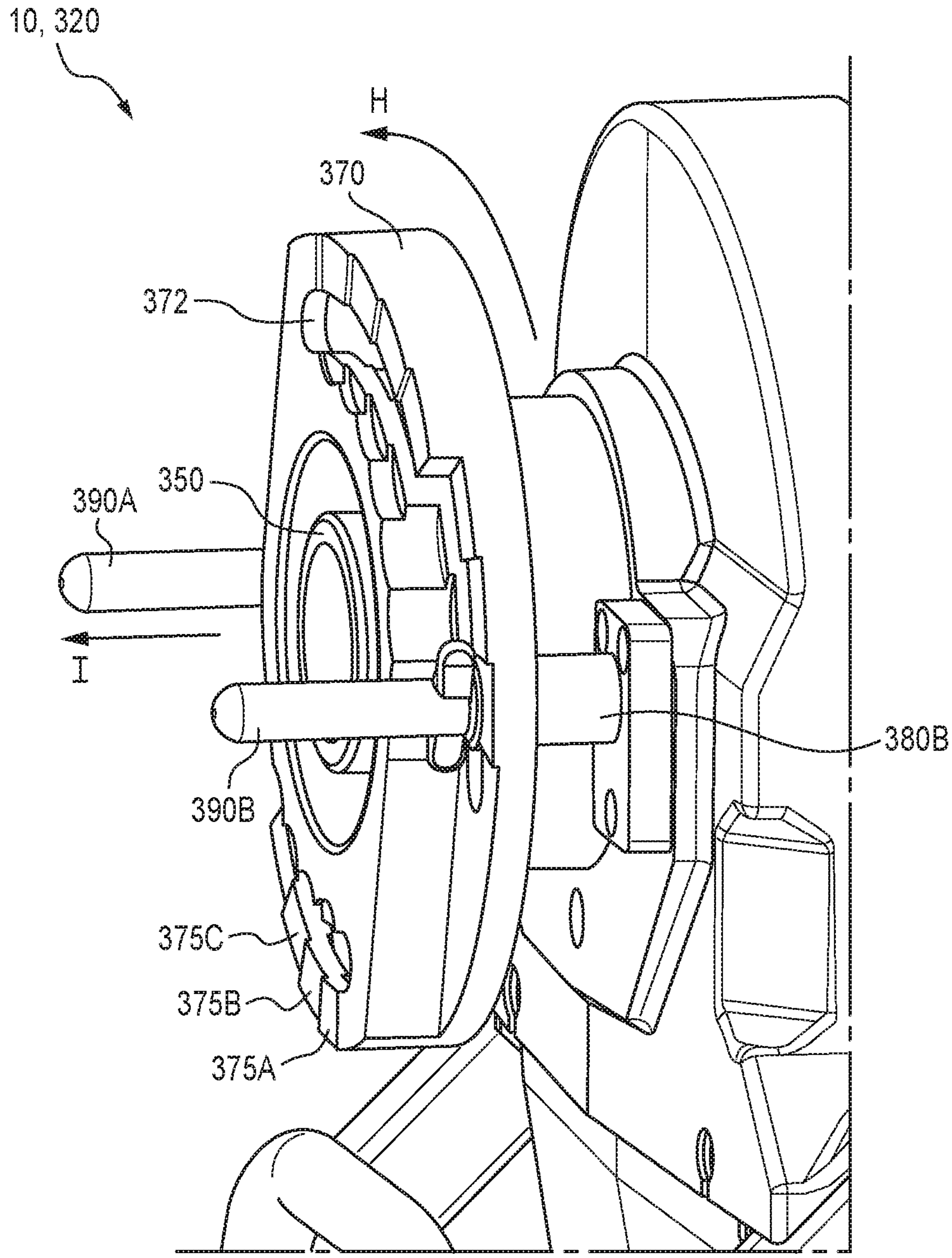

FIG. 14

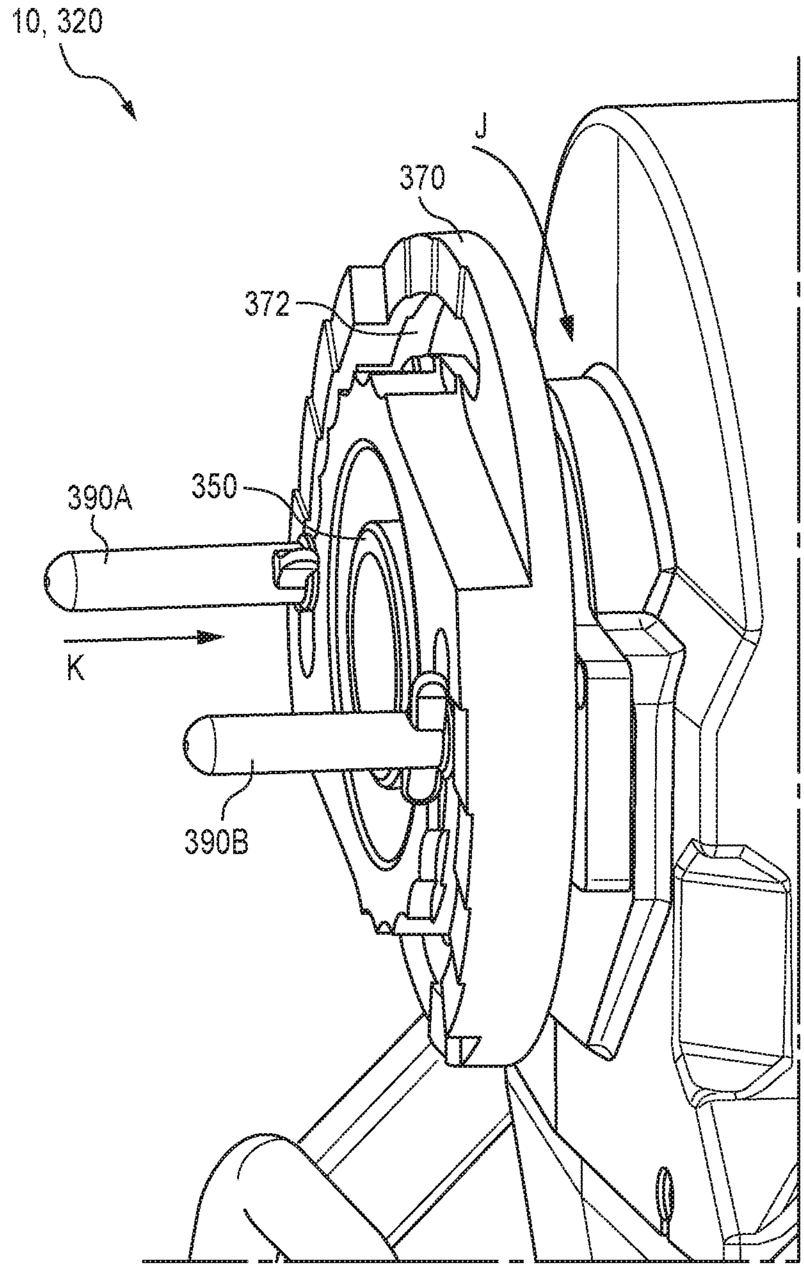

FIG. 15

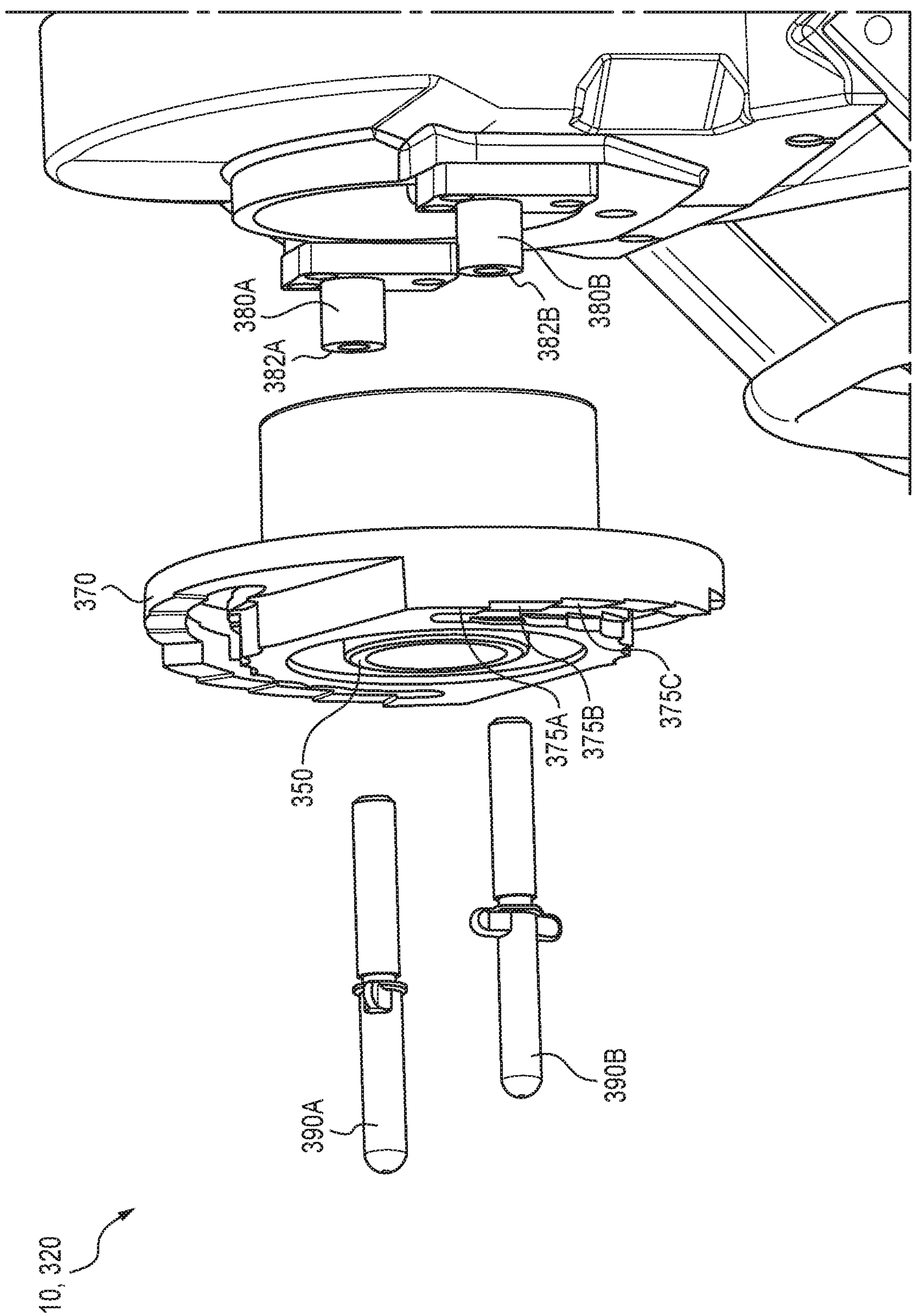

FIG. 16

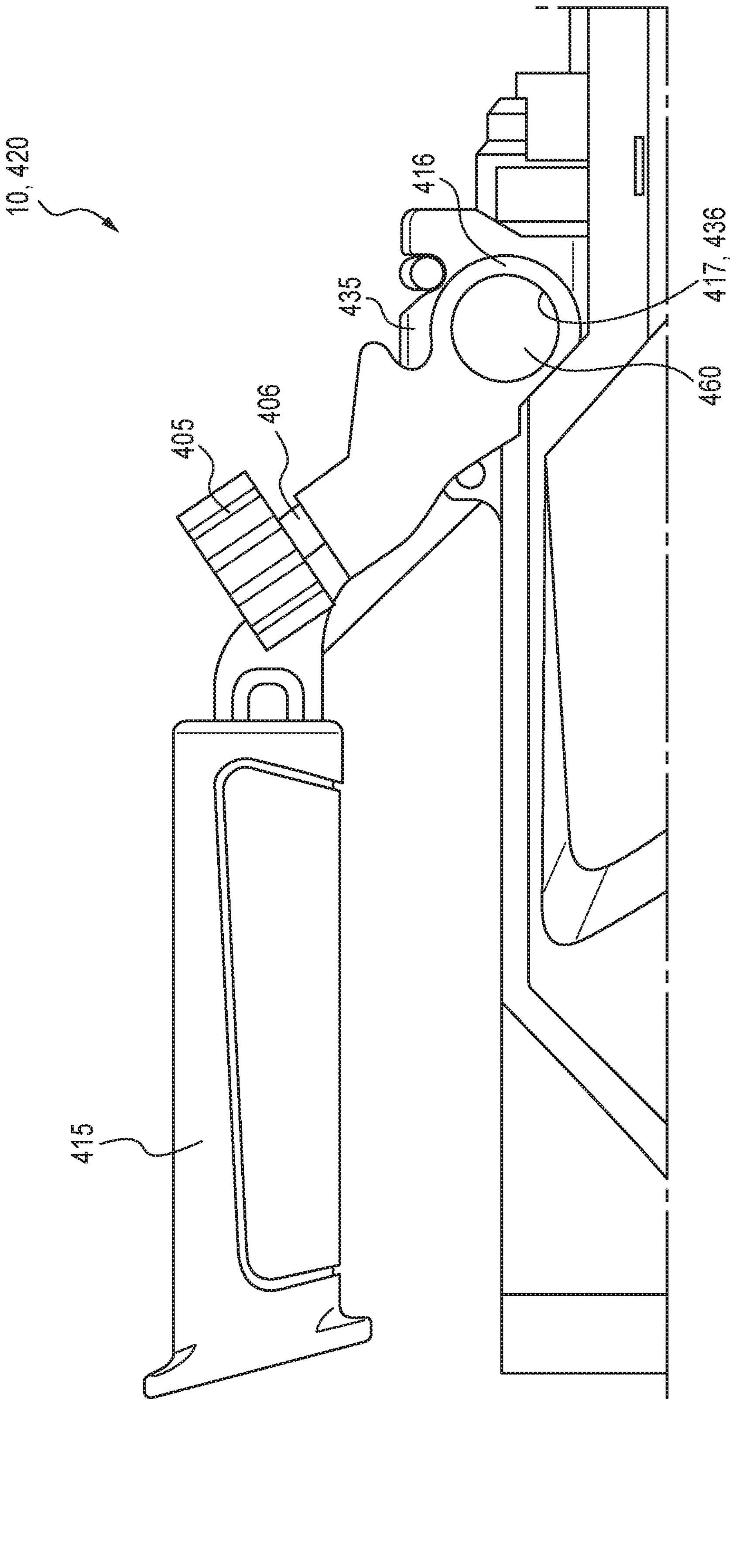

FIG. 17

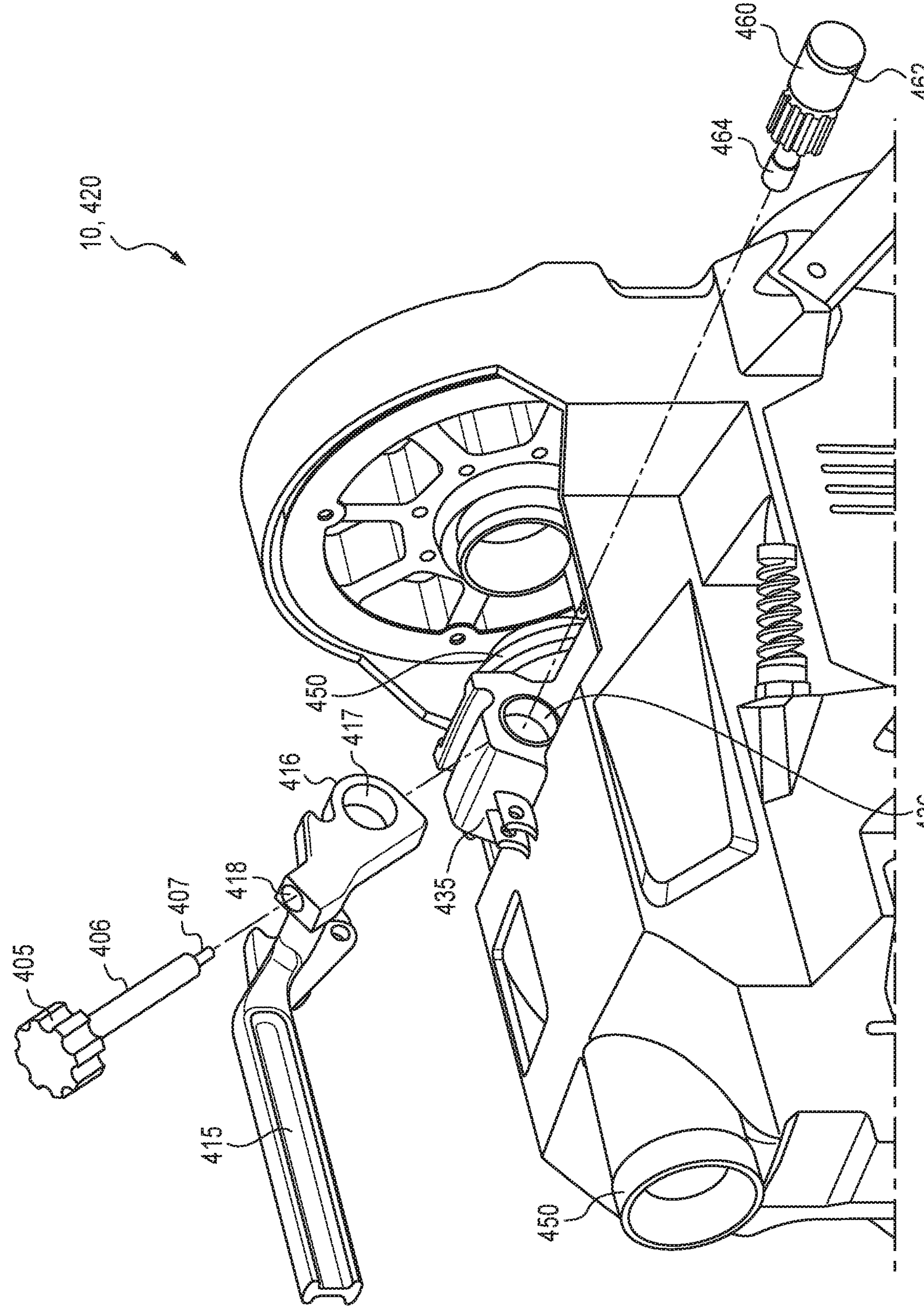

FIG. 18

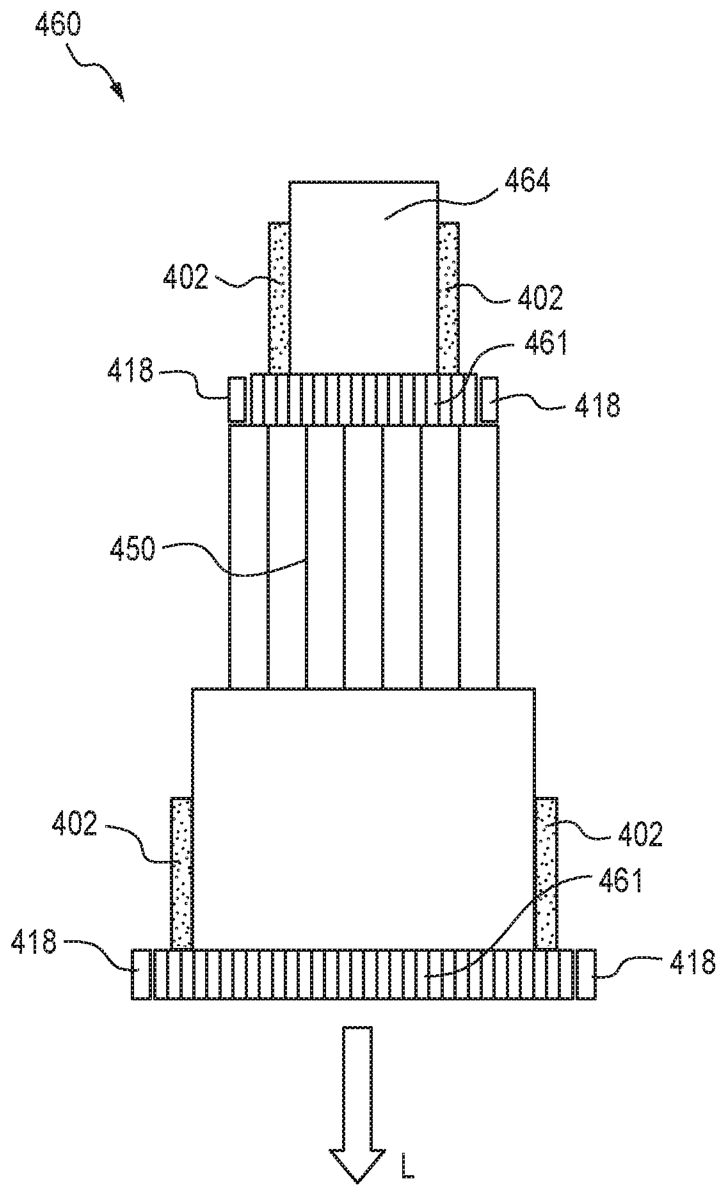

FIG. 19

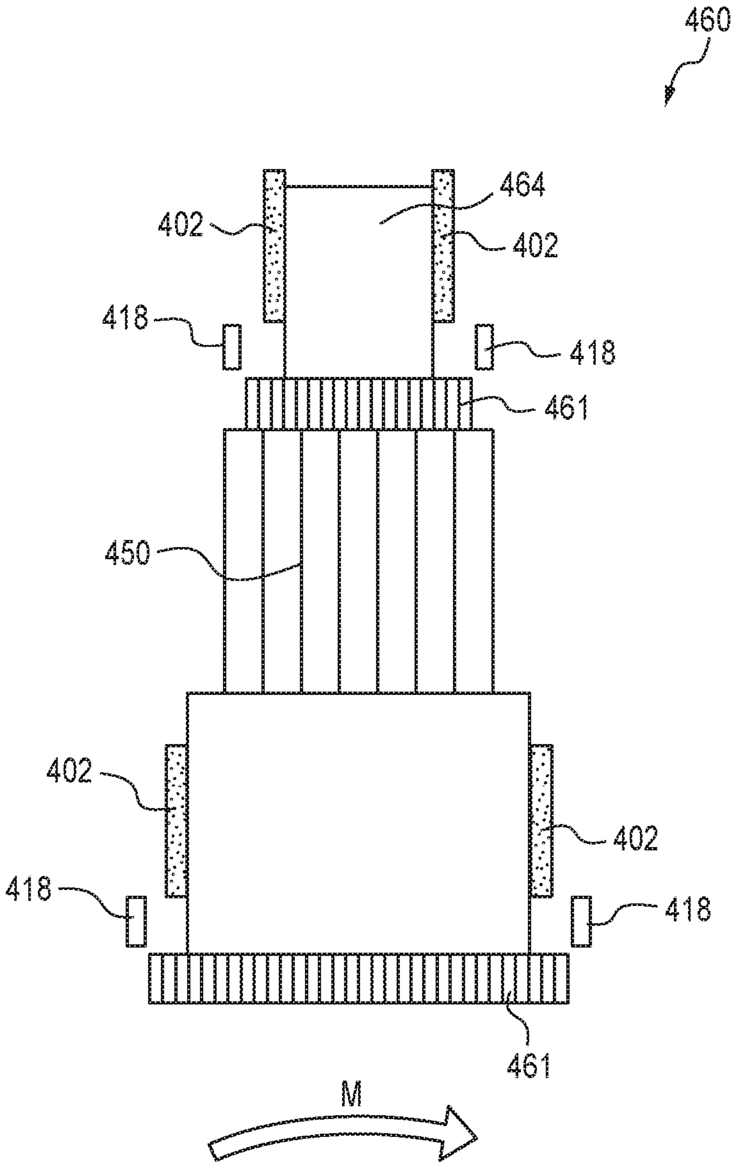

FIG. 20

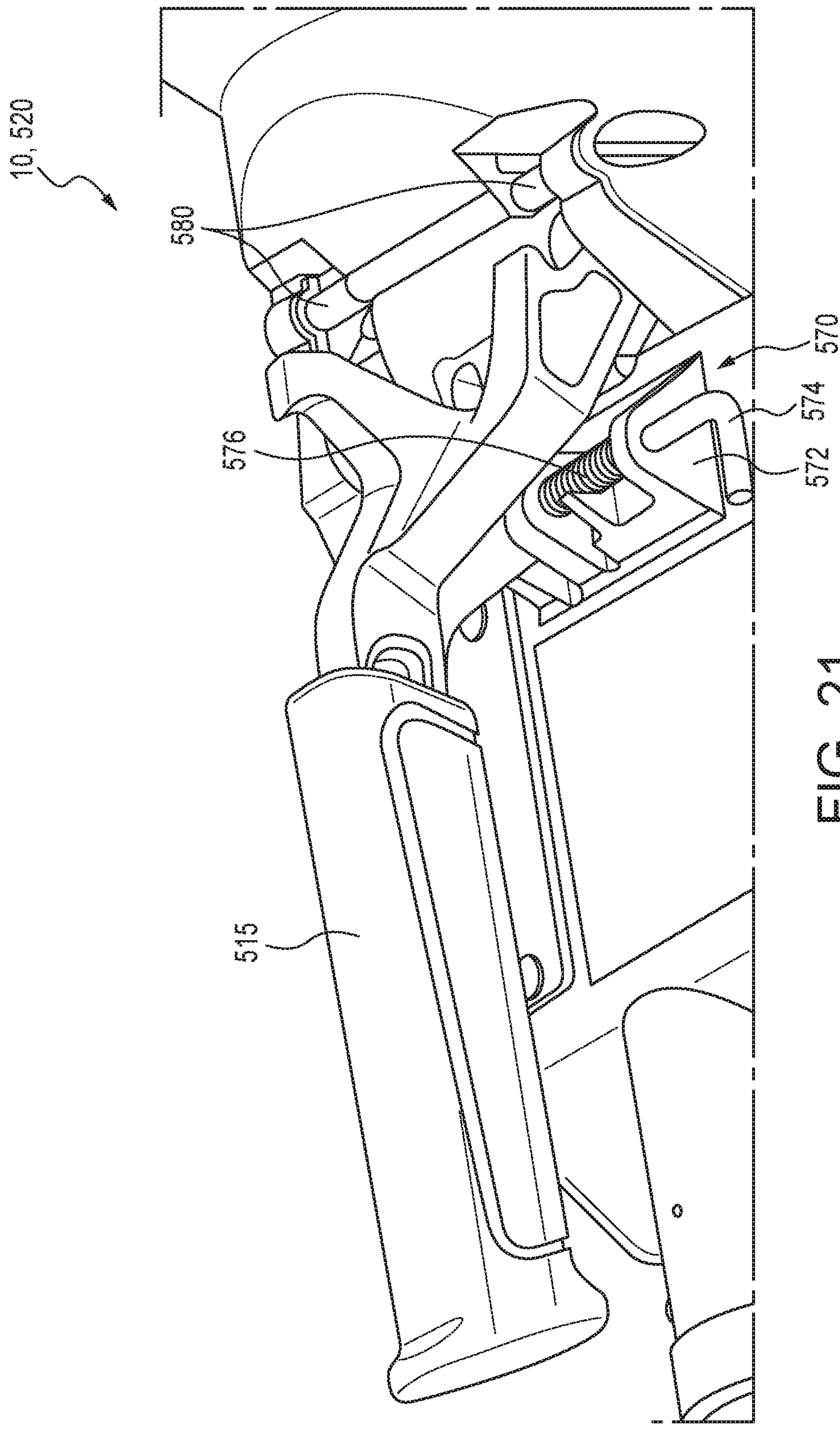

FIG. 21

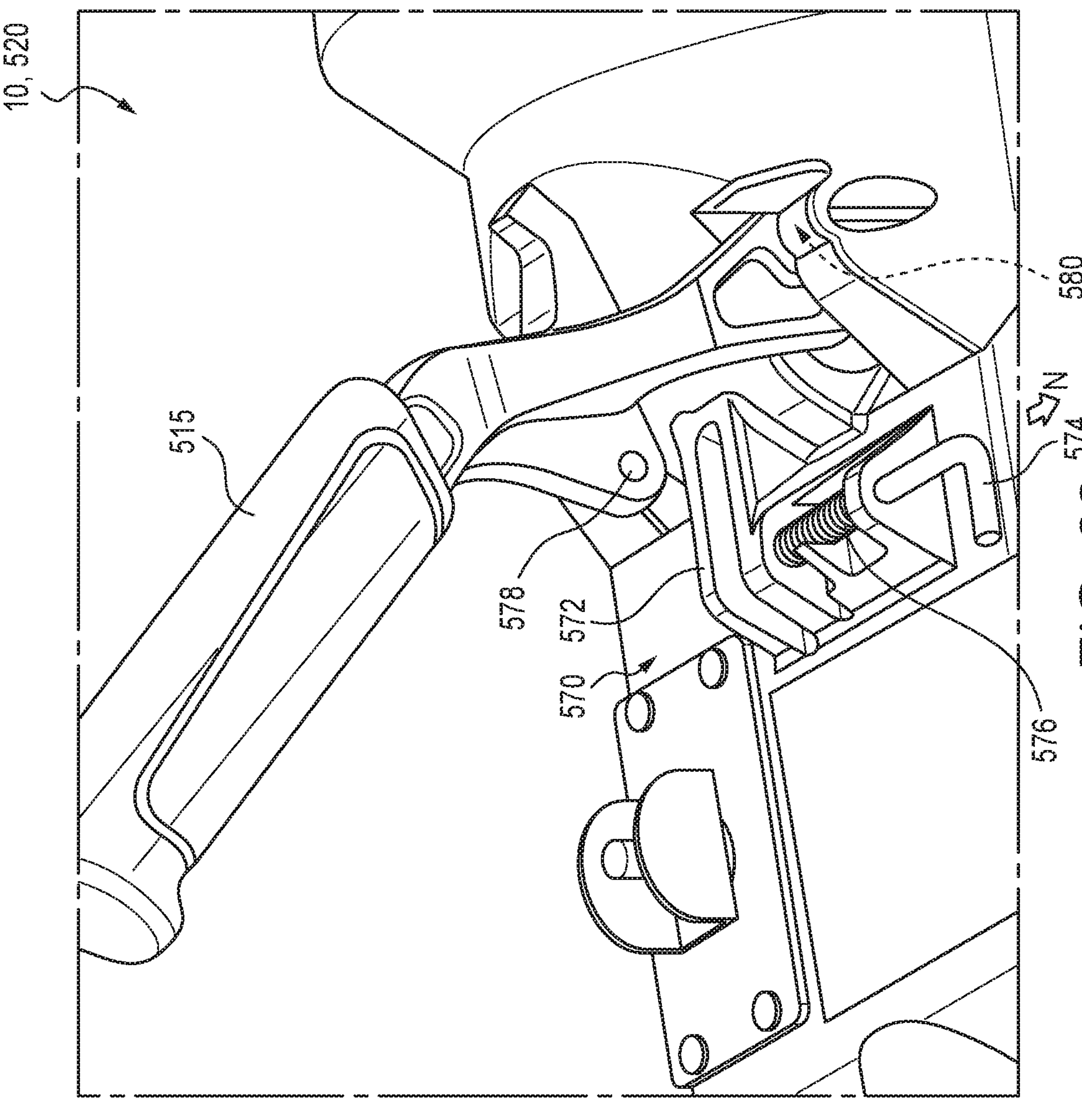

FIG. 22

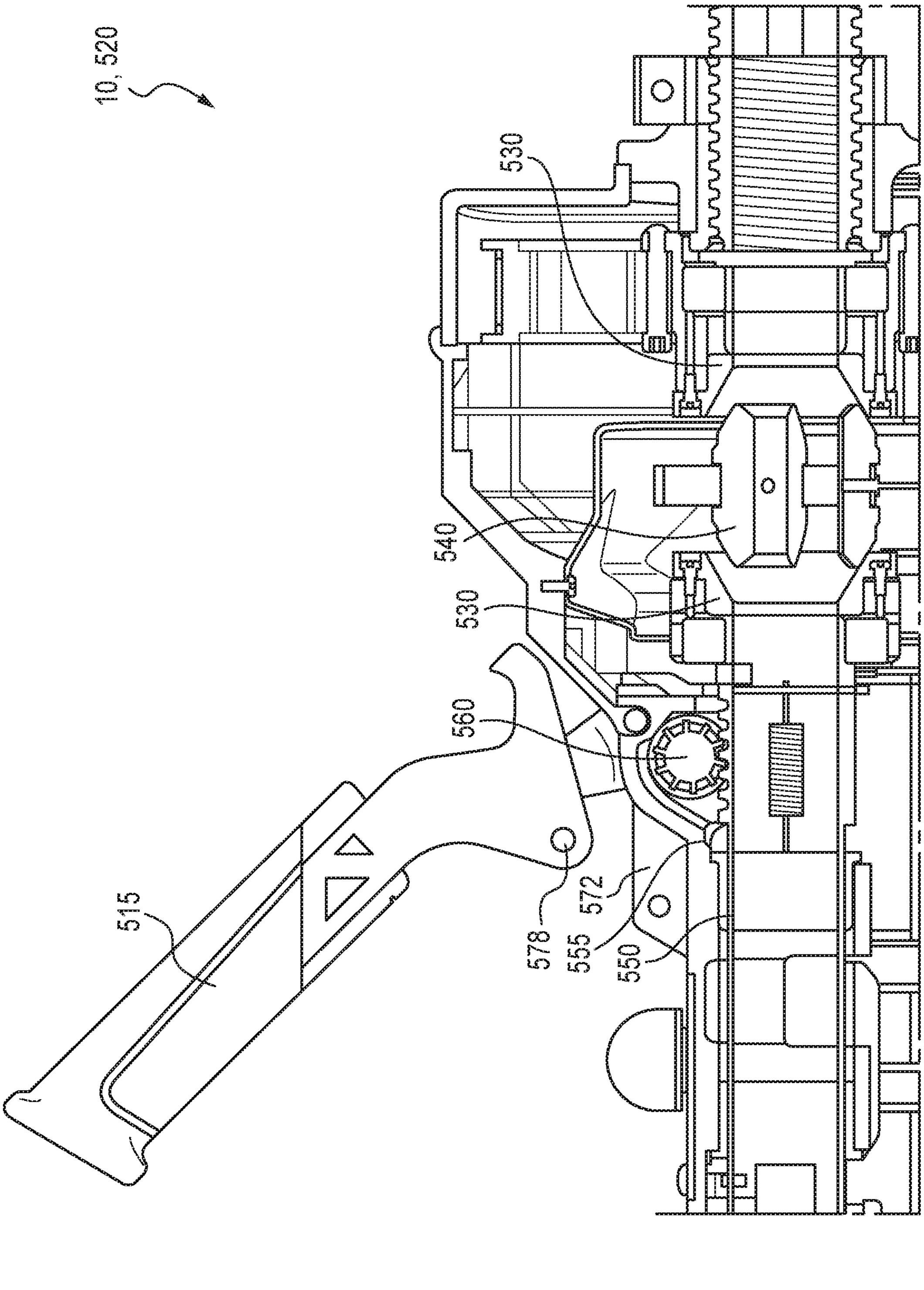

FIG. 23

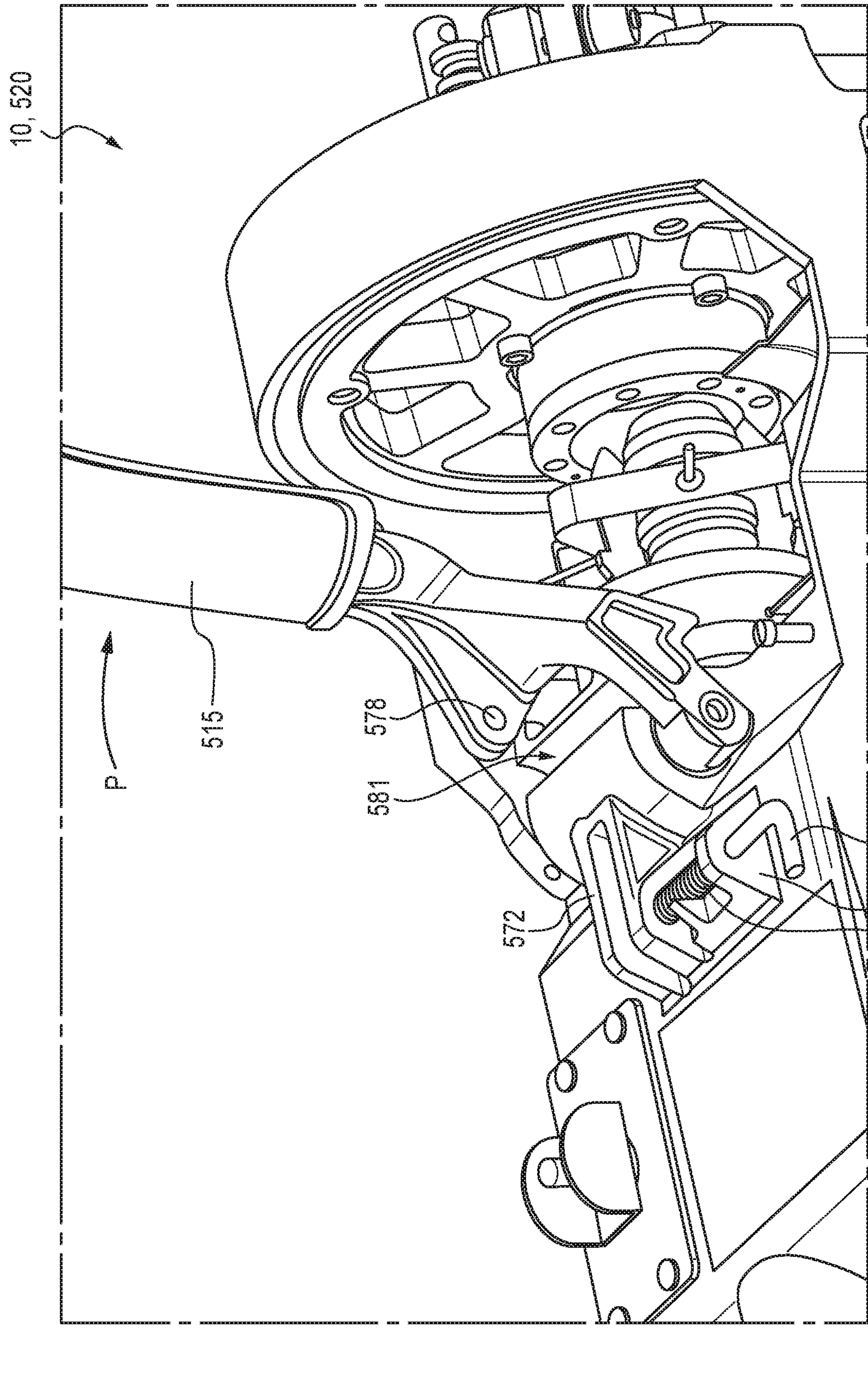

FIG. 24

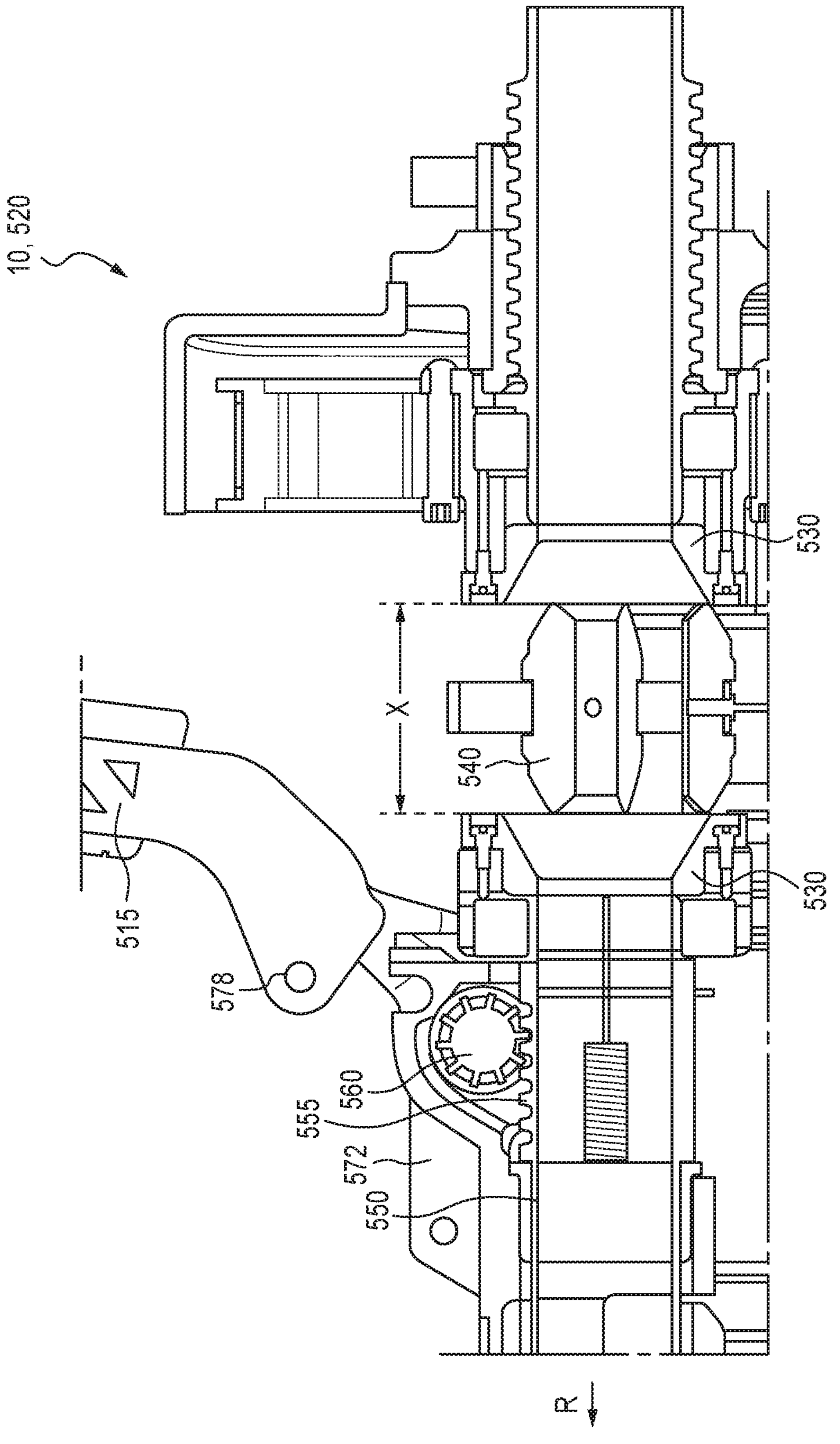

FIG. 25

TOOL-LESS CLUTCH ADJUSTMENT AND REMOVAL FOR DRAIN CLEANER

CROSS REFERENCES TO RELATED APPLICATIONS

This application claims priority from U.S. provisional application Ser. No. 62/598,520 filed on Dec. 14, 2017.

FIELD

The present subject matter relates to drain cleaning machines and particularly such machines using adjustable clutches for accommodating drain cleaning cables having different diameters.

BACKGROUND

Many drain cleaning machines are designed to accommodate drain cleaning cables of different sizes, i.e., diameters. Use of different cable sizes enables a greater range of drain pipe sizes that can be cleaned. In addition, in many applications a user may select one of a variety of different cable diameters that could potentially be used. For example, selection of a smaller cable diameter provides a lighter and more flexible cable option to the user during operation as compared to a larger cable diameter. And selection of a larger cable diameter provides a more robust cable option for clearing difficult blockage, as compared to a smaller cable diameter.

Drain cleaning cables are axially rotated by the drain cleaning machine to clear blockages in drain lines and/or to aid the cable in moving within the drain line such as during cable extension. In order to rotate the cable, a clutch of the drain cleaning machine must be "set" to allow the clutch jaws to sufficiently engage the cable when the actuating mechanism is activated. Adjusting or setting the clutch of such drain cleaning machines requires various tools for example one or more wrenches or similar tools. Since most drain cleaning operations are performed at a job site or in an area remote from a user's tools, the tools required for clutch adjustment must be brought by the user to the drain cleaning machine. This further increases the demands on the user and increases the potential for loss or misplacement of the tools.

Accordingly, in view of these and other concerns, a need exists for a strategy and assembly by which a clutch of a drain cleaning machine can be adjusted to accommodate different cable sizes without tools. Such a strategy and assembly would significantly increase the operating efficiency of the user and provide greater convenience during use of the drain cleaning machine. Further, as the clutch expectedly wears from use, the clutch position could likewise be adjusted by the user quickly and without the use of tools to maintain the most ergonomic or convenient operating setting.

SUMMARY

The difficulties and drawbacks associated with previous approaches are addressed in the present subject matter as follows.

In one aspect, the present subject matter provides an adjustable clutch assembly comprising a plurality of positionable clutch members. Each clutch member defines an engagement face and at least one ramp region. The clutch assembly also comprises at least one movable clutch cone defining a cone face. The clutch assembly also comprises an

adjustment shaft defining a proximal end, a distal end, a hollow interior extending between the proximal end and the distal end, and a longitudinal axis. The adjustment shaft also defines a threaded engagement region, wherein upon rotation of the adjustment shaft, the adjustment shaft is linearly displaced relative to the plurality of clutch members. The clutch assembly additionally comprises a locking clamp positionable between a free position in which the adjustment shaft can be rotated by a user to effect linear displacement of the shaft and a locked position in which the adjustment shaft can not be rotated by a user to effect linear displacement of the shaft.

In another aspect, the present subject matter provides an adjustable clutch assembly comprising a plurality of positionable clutch members. Each clutch member defines an engagement face and at least one ramp region. The clutch assembly also comprises at least one movable clutch cone defining a cone face. The clutch assembly also comprises an adjustment shaft defining a proximal end, a distal end, a hollow interior extending between the proximal end and the distal end, and a longitudinal axis. The adjustment shaft also defines at least one aperture accessible along a circumferential region between the proximal end and the distal end. The clutch assembly also comprises a sleeve disposed about the adjustment shaft. The sleeve defines at least one arcuate cam slot. The clutch assembly also comprises a lever sized and shaped to be inserted in the arcuate cam slot of the sleeve and the aperture of the adjustment shaft. Upon (i) insertion of the lever in both the arcuate cam slot of the sleeve and the aperture of the adjustment shaft, and (ii) displacement of the lever within the arcuate cam slot, the adjustment shaft is linearly displaced relative to the plurality of clutch members.

In another aspect, the present subject matter provides an adjustable clutch assembly comprising a plurality of positionable clutch members. Each clutch member defines an engagement face and at least one ramp region. The clutch assembly also comprises at least one movable clutch cone defining a cone face. The clutch assembly also comprises at least one stationary sloped component defining a distal sloped face. The clutch assembly also comprises an adjustment shaft and a sloping cam component integral with each other. The sloping cam component defines at least one guide slot extending arcuately around the adjustment shaft. The clutch assembly also comprises at least one fastener extending through the guide slot and adapted to selectively engage a corresponding stationary sloped component. Upon loosening of the at least one fastener from the corresponding stationary sloped component, the integral adjustment shaft and sloping cam component can be rotated about a longitudinal axis of the adjustment shaft which thereby results in axial displacement of the adjustment shaft relative to the at least one stationary sloped component.

In still another aspect, the present subject matter provides an adjustable clutch assembly comprising a plurality of positionable clutch members. Each clutch member defines an engagement face and at least one ramp region. The clutch assembly also comprises at least one movable clutch cone defining a cone face. The clutch assembly also comprises at least one stationary boss defining a distal flat face. The clutch assembly also comprises an adjustment shaft and a cam component integral with each other. The cam component defines at least one guide slot extending arcuately around the adjustment shaft, and the cam component including a plurality of steps adjacent the guide slot. The clutch assembly also comprises at least one fastener extending through the guide slot and adapted to selectively engage a corresponding stationary boss. Upon loosening of the at least one fastener from the corresponding stationary boss, the integral adjustment shaft and cam component can be rotated about a longitudinal axis of the adjustment shaft which thereby results in axial displacement of the adjustment shaft relative to the at least one stationary boss.

In yet another aspect, the present subject matter provides an adjustable clutch assembly comprising a plurality of positionable clutch members. Each clutch member defines an engagement face and at least one ramp region. The clutch assembly also comprises at least one movable clutch cone defining a cone face. The clutch assembly also comprises an adjustment shaft defining a proximal end, a distal end, a hollow interior extending between the proximal end and the distal end, and a longitudinal axis. The clutch assembly also comprises a linear gear rack affixed to the adjustment shaft. The clutch assembly also comprises a rotatable pinion shaft including (i) a gear region engaged with the linear gear rack and (ii) a worm wheel. The clutch assembly additionally comprises a clutch adjustment member having a worm gear. And, the clutch assembly comprises a clutch actuation handle having a passage sized and shaped to receive the pinion shaft, and having a receptacle adapted to receive the clutch adjustment member. Upon rotation of the worm gear of the clutch adjustment member; the pinion shaft is rotated, thereby causing linear displacement of the adjustment shaft.

In yet another aspect, the present subject matter provides an adjustable clutch assembly comprising a plurality of positionable clutch members. Each clutch member defines an engagement face and at least one ramp region. The clutch assembly also comprises at least one movable clutch cone defining a cone face. The clutch assembly also comprises an adjustment shaft defining a proximal end, a distal end, a hollow interior extending between the proximal end and the distal end, and a longitudinal axis. The clutch assembly also comprises a linear gear rack affixed to the adjustment shaft. The clutch assembly also comprises a rotatable pinion shaft including a gear region engaged with the linear gear rack. And, the clutch assembly comprises a clutch actuation handle having a passage sized and shaped to receive the pinion shaft, and having a receptacle adapted to receive the clutch adjustment member. The pinion shaft is selectively displaceable between (i) a free position in which rotation of the pinion shaft is independent of the handle and (ii) an engaged position in which rotation of the pinion shaft is dependent upon the handle.

In still another aspect, the present subject matter provides an adjustable clutch assembly comprising a plurality of positionable clutch members. Each clutch member defines an engagement face and at least one ramp region. The clutch assembly also comprises at least one movable clutch cone defining a cone face. The clutch assembly also comprises an adjustment shaft defining a proximal end, a distal end, a hollow interior extending between the proximal end and the distal end, and a longitudinal axis. The clutch assembly also comprises a linear gear rack affixed to the adjustment shaft. The clutch assembly also comprises a rotatable pinion shaft including a gear region engaged with the linear gear rack. The clutch assembly additionally comprises a clutch actuation handle engaged with the pinion shaft such that displacement of the handle causes rotation of the pinion shaft, and corresponding movement of the linear gear rack and the adjustment shaft. The clutch assembly also comprises a selectively positionable locking pin assembly positionable between a locked position in which the clutch actuation handle can be displaced, and an unlocked position in which the clutch actuation handle can not be displaced.

As will be realized, the subject matter described herein is capable of other and different embodiments and its several details are capable of modifications in various respects, all without departing from the claimed subject matter. Accordingly, the drawings and description are to be regarded as illustrative and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic partial perspective view of a portion of a drain cleaning machine utilizing an embodiment of an assembly for tool-less clutch adjustment in accordance with the present subject matter.

FIG. **2** is a schematic partial cross sectional view of the assembly of FIG. **1**.

FIG. **3** is a schematic perspective end view of a base sleeve used in the drain cleaning machine of FIGS. **1-2**.

FIG. **4** is a schematic elevational view of the base sleeve depicted in FIG. **3**.

FIGS. **5** to **8** are schematic views of a drain cleaning machine and components utilizing another embodiment of an assembly for tool-less clutch adjustment in accordance with the present subject matter.

FIGS. **9** to **12** are schematic partial perspective and assembly views of a portion of a drain cleaning machine utilizing another embodiment of an assembly for tool-less clutch adjustment in accordance with the present subject matter.

FIGS. **13** to **16** are schematic partial perspective and assembly views of a portion of a drain cleaning machine utilizing another embodiment of an assembly for tool-less clutch adjustment in accordance with the present subject matter.

FIGS. **17** to **20** are schematic partial elevational view and various additional views of a portion of a drain cleaning machine utilizing another embodiment and a variant version of an assembly for tool-less clutch adjustment in accordance with the present subject matter.

FIGS. **21** to **25** are schematic partial perspective and cross sectional views of a drain cleaning machine utilizing another variant of the embodiment depicted in FIGS. **17-20**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present subject matter relates to sectional drain cleaning equipment that utilizes a clutch mechanism to contact and engage a drain cleaning cable to transmit rotation from the equipment to the cable for the purpose of feeding or retrieving the cable, or for clearing a drain blockage, when initiated or desired by an operator.

The present subject matter could further relate to any application in which a clutch is selectively engaged onto a device or component to be rotated and the starting position of the clutch must be set, or preset, based on the free state of the component to be engaged.

Similarly, the present subject matter also relates to applications in which the clutch may wear and the starting position of the clutch surface relative to the component to be engaged, should be adjusted to maintain consistency in operation of the clutch and equipment.

And, the present subject matter relates to applications in which the clutch is removed for service or replacement. Specifically, if the clutch needs to be removed for service or replacement, the present subject matter provides a tool-free, efficient means to remove the clutch by utilizing the normal operating range of motion of the actuating mechanism and additional provided travel within the clutch system.

In accordance with an embodiment of the present subject matter, in order to achieve clutch adjustment in a drain cleaning machine for different drain cable sizes or to account for material wear in the clutch system, a locking assembly is provided having an over-center lever that is pivoted, rotated, or otherwise moved to release circumferential pressure from a locking clamp. When the clamping pressure is released, a threaded adjustment shaft can be freely and manually rotated by a user. As the shaft is rotated in one direction, the entire shaft moves towards the clutch assembly through thread screwing action, compressing the clutch jaws inward via contact with corresponding clutch cone surfaces and spring force to accommodate a smaller diameter, such as would be desired for a smaller drain cleaning cable, or to compensate for material wear. When the adjustment shaft is rotated in the opposite direction by the user, the clutch jaws move outward to accommodate a larger diameter, such as would be desired for a larger drain cleaning cable.

Specifically, referring to FIGS. **1** and **2**, a portion of a drain cleaning machine **10** is depicted having an adjustable clutch assembly **20** in accordance with an embodiment of the present subject matter. The clutch assembly **20** comprises a plurality of positionable clutch members **40** such as members **40**A and **40**B. Each clutch member defines an engagement face **42** such as face **42**A and **42**B for contacting a drain cleaning cable (not shown) and one or more ramp regions **44** such as regions **44**A and **44**B. These aspects are described in greater detail herein. Typically, the number of clutch members **40** associated with the clutch assembly **20** is within a range of from 2 to 10 with a preferred total number of positionable clutch members **40** being three (3). However, it will be understood that the present subject matter includes a wide array of clutch assemblies **20** having different types and numbers of clutch members **40**. In the embodiment depicted in FIGS. **1** and **2**, each clutch member, e.g., **40**A and **40**B, is radially positionable relative to a longitudinal axis A which is depicted in FIGS. **1** and **2**, and described in greater detail herein with another component of the clutch assembly, an adjustment shaft **50**.

The adjustment shaft **50** is typically in the form of a longitudinal cylindrical member defining a proximal end **52**, an opposite distal end **54**, and a hollow interior **56** extending between the ends **52**, **54**. The adjustment shaft **50** also includes a threaded engagement region **58** typically along its external circumferential outer face and at least partially between the ends **52**, **54**. The adjustment shaft **50** is threadedly engaged with a threaded region **72** of a base sleeve **70**, typically affixed or otherwise incorporated in the drain cleaning machine **10**. As will be understood, rotation of the adjustment shaft **50** about axis A results in linear displacement of the adjustment shaft in either of the directions of arrows B or C.

The clutch assembly **20** also comprises one or more clutch cones **30**, each having a cone face **32**. At least a portion of the clutch cones **30** are affixed or engageable with the adjustment shaft **50** such that linear displacement of the shaft **50** in the direction of arrow B results in linear displacement of the clutch cones **30** toward the clutch members **40**. In certain versions of the clutch assembly **20**, the clutch cones **30** on one side of the clutch members **40** move toward the clutch cones **30** on an opposite side of the clutch members **40**, and vice-versa. That is, referring to FIG. **2**, the clutch cones **30** on the left side of the clutch members **40** move toward the clutch members **40** in the direction of arrow C, and the clutch cones **30** on the right side of the clutch members **40** move toward the clutch members **40** in the direction of arrow B.

The clutch cones **30** define one or more cone faces **32** that are directed toward corresponding ramp regions **44** of the clutch members **40**. Upon displacement of the clutch cones **30** toward the clutch members **40**, the cone faces **32** contact corresponding ramp regions **44** of the clutch members **40** and with continued linear displacement of the adjustment shaft **50** in the direction of arrow B, the clutch members **40** are positioned or moved radially inward toward longitudinal axis A. The clutch members **40** can be moved radially inward until they contact and frictionally engage a drain cleaning cable disposed in the hollow interior **56** of the adjustment shaft **50**.

The clutch assembly **20** also comprises a locking assembly such as including a locking clamp **85** which is positionable between a free position in which the adjustment shaft **50** can be manually rotated by a user, typically without tools, to effect linear displacement of the shaft **50**; and a locked position in which the adjustment shaft **50** can not be manually rotated by a user. In many applications, a typical user can manually rotate the adjustment shaft if the shaft can be rotated using a torque force of less than about 15 in-lb. If a torque force of about 50 in-lb. or more is required to rotate the adjustment shaft, then the shaft is not manually rotatable as described herein. Typically, in the locked position, the locking clamp **85** frictionally engages the adjustment shaft **50** in a desired position. In the embodiment depicted in FIGS. **1** and **2**, the locking clamp **85** is in the form of a circumferential member **80** surrounding the periphery of the base sleeve **70** and the adjustment shaft **50** threadedly engaged therewith. The locking clamp **85** in many versions also includes an over-center lever **90** engageable with a first end **82** and a second end **84** of the circumferential member **80** via a member **81**. As will be understood, upon selective positioning of the lever **90**, the locking assembly, which in the version shown in the referenced figures is in the form of a locking clamp **85**, can be positioned between the noted free position and the noted locked position. Thus, upon positioning the lever **90** to the locked position such as depicted in FIG. **1**, the locking clamp **85** urges the first end **82** and the second end **84** toward each other, thereby increasing the force applied to the adjustment shaft **50** and frictionally engaging the shaft **50** in a desired linear or axial position. As will be understood, the lever **90** is positionable or rotatable about an axle **91**. The lever **90** can be positioned to the unlocked position by moving the lever **90** about axle **91** in the direction of arrow Q. Moving the lever **90** to the unlocked position typically increases the distance between the ends **82** and **84**, thereby reducing the force applied to the adjustment shaft **50**.

A variation to this embodiment is the use of an ACME thread profile for the adjustment shaft movement with a relatively large length-to-diameter ratio of the male and female thread engagement. Thus, the threaded region **58** of the adjustment shaft **50** and the corresponding threaded region **72** of the base sleeve **70** each utilize an ACME thread profile with a relatively large length-to-diameter ratio. In particular versions, this ratio is within a range of from 0.75:1 to 2:1. In certain versions, a ratio of 1.36:1 has been found suitable. However, it will be appreciated that the present subject matter includes assemblies utilizing different thread ratios and thread profiles different than ACME thread profiles. Further, the present subject matter can use a multiple start thread profile to increase the speed of adjustment. In a particular embodiment, a 1.75 inch, 0.25 inch pitch, 0.5 inch lead stub ACME thread with a double start is used.

Through this means of adjustment, the user does not need to bring additional tools to the jobsite and can quickly adjust the clutch position to a convenient and ergonomically-preferred operating position. This can provide greater life to the clutch as the operator can compensate for any wear and utilize the worn components further in time.

In particular versions, the drain cleaning machine **10** comprises a base sleeve **70** as shown in FIGS. **3** and **4**. The base sleeve **70** is disposed between the adjustment shaft **50** and the locking clamp **85**. The base sleeve **70** defines a proximal end **73** and an opposite distal end **74**. A circumferential ridge **78** may be provided adjacent the proximal end **73**. The base sleeve **70** defines one or more slots extending through a circumferential wall of the sleeve **70**. The slot(s) promote flexure of the base sleeve **70** upon tightening or locking of the locking clamp **85** and specifically the circumferential member **80**. Upon tightening or locking of the clamp, the width of the slot(s) is reduced to thereby create the clamping force around the adjustment shaft **50**.

In the particular embodiment shown in FIGS. **3** and **4**, the base sleeve **70** defines a circumferential slot **75** extending along a portion of the circumference of the sleeve **70**; and an axial slot **76** extending from the distal end **74** toward the proximal end **73** to a location intersecting the circumferential slot **75**. Typically, the circumferential slot **75** extends along an arc within a range of from about 90° to about 270° with 180° being typical. The circumferential slot **75** is located at an axial location between the ends **73**, **74** which is generally aligned with and spaced a distance from the distal end **74** equal or substantially so to the width of the circumferential member **80**. Although not wishing to be limited to any particular dimensions, the circumferential slot **75** has a width of 0.060 inches and the axial slot **76** has a width of 0.125 inches. The axial slot **76** extends parallel with the longitudinal axis A shown in FIGS. **1** and **2**.

Another embodiment to achieve tool-less clutch adjustment is by use of an assembly having an adjustment shaft with an outwardly and preferably radially extending lever and a coaxial stationary sleeve with a cam profile cut circumferentially. The adjustment shaft can be linearly displaced by moving or rotating the radial lever through the cam profile of the stationary sleeve, thereby inducing axial motion of the adjustment shaft. This configuration can include multiple cam profiles defined around the stationary sleeve, depending on the desired axial linear motion, and utilize one or more guide pins fixed to the adjustment shaft to facilitate navigation through the cam profile. As previously described, the clutch can be compressed or expanded based on the adjustment shaft linear axial position. In certain versions of this embodiment, axial motion of the adjustment shaft during use can be prevented by moving or rotating the radial lever to lock a fixed joint, for example, a bolted joint, between the adjustment shaft and the stationary sleeve.

Specifically, referring to FIGS. **5-8**, portions of a drain cleaning machine **10** utilizing another embodiment of an assembly for tool-less clutch adjustment are illustrated. The drain cleaning machine **10** comprises a clutch assembly **120** as previously described and including the noted clutch cones and clutch members. In the embodiment of FIGS. **5-8**, the assembly **120** comprises an adjustment shaft **150**, a stationary sleeve **170**, and a radial locking lever **180**, all of which are described in greater detail herein.

The adjustment shaft **150** defines a proximal end **152**, an opposite distal end **154**, and a hollow interior **156** extending between the ends **152**, **154**. The adjustment shaft **150** also defines one or more apertures **159** which may be threaded in the circumferential wall of the shaft **150** as depicted in FIGS. **5** and **6**. The apertures **159** may also be provided in an optional collar **160** affixed to the shaft **150**. In this configuration, the apertured collar **160** provides an extension for the apertures **159**. These aspects are described in greater detail herein.

The stationary sleeve **170** surrounds or substantially surrounds the adjustment shaft **150**. In many versions, the sleeve **170** is concentrically disposed about the adjustment shaft **150**. The sleeve **170** is typically affixed to a frame or housing component of the drain cleaning machine **10**. The sleeve **170** defines one or more arcuate cam slots **172**.

The radial locking lever **180** defines an insertion end **182**, an opposite gripping end **184** at which may be disposed a handle **186**, and a shoulder **185** located between the insertion end **182** and the gripping end **184**. In many versions, a threaded region is defined along the outer surface of the lever **180** at the insertion end **182**. The lever **180** and particularly the insertion end **182**, is sized and shaped to be inserted within the arcuate cam slots **172** and the apertures **159** of the adjustment shaft **150**.

The radial locking lever **180** is removable from the adjustment shaft **150**. In certain versions, the attachment could be such that the attachment requires a retaining ring or pin to be removed in order to separate the lever **180** from the shaft **150** in order to prevent inadvertent removal of the lever **180** during use, but the components would be ultimately removable based on normal manufacturing methods to more efficiently create the components.

The axial position of the adjustment shaft **150** in the machine **10** is selected or changed, by placing the lever **180** in the arcuate cam slot **172** in the stationary sleeve **170** and in an aperture **159** in the adjustment shaft **150**, and then moving the lever **180** in the cam slot **172**. That movement of the lever **180** about the longitudinal axis of the sleeve **170** and the shaft **150** results in axial movement of the shaft **150**. As the lever **180** is moved through the arcuate cam slot **172** of the stationary sleeve **170**, the axial position of the adjustment shaft **150** changes since the radial lever **180** and the adjustment shaft **150** are fixed relative to each other and the arcuate cam slot **172** changes the position of the radial locking lever **180** relative to the position of the stationary sleeve **170**.

In certain versions, the radial locking lever **180** is typically not removed from the adjustment shaft **150**. Instead, the radial locking lever **180** is moved or rotated and a threaded joint between the radial locking lever **180** and the adjustment shaft **150** allows the radial locking lever **180** to move radially inward towards the center of the adjustment shaft **150** until a shoulder **185** in the radial locking lever **180** contacts the stationary sleeve **170**. This configuration creates a fastened joint similar to a screw being turned into the adjustment shaft **150** until the head of the screw reaches the stationary sleeve **170**.

In certain versions, the insertion end **182** of the radial locking lever **180** includes a threaded region, for example male threads that engage female threads cut directly into the adjustment shaft **150** or into an optional shaft collar **160** or similar component that is fixed onto the adjustment shaft **150**. When the radial locking lever **180** is rotated about its longitudinal axis, the position of the radial locking lever **180** moves inward toward the axis of the adjustment shaft **150**, radial to the adjustment shaft, until the shoulder **185** of the radial locking lever **180** contacts the stationary sleeve **170**. The threaded connection allows the position of the radial locking lever **180** to be fixed relative to the stationary sleeve **170** and, since the radial locking lever **180** is fixed radially to the adjustment shaft **150**, the adjustment shaft **150** is likewise fixed axially relative to the stationary sleeve **170**.

Yet another embodiment to accomplish tool-less clutch adjustment is by use of an assembly having an adjustment shaft with a sloping cam component that extends helically around the shaft to engage a similar sloped helix surface on one or more stationary sloped component(s). By manually loosening attachment fasteners, the adjustment shaft can be manually rotated such that the helical cam of the adjustment shaft slides against the sloped surface of the stationary component(s), thereby producing axial linear motion of the adjustment shaft. As previously described, the clutch is compressed or expanded based on the adjustment shaft linear axial position. The adjustment shaft can be locked in position via hand-driven fasteners.

Referring to FIGS. **9** to **12**, a portion of a drain cleaning machine **10** with an adjustable clutch assembly **220** is depicted. The clutch assembly **220** comprises the previously described assembly of clutch cones and clutch members. In the embodiment of FIGS. **9** to **12**, the noted assembly **220** comprises an adjustment shaft **250**, a sloping cam component **270**, one or more stationary sloped components **280** such as stationary sloped components **280**A and **280**B, and one or more attachment fasteners **290** such as fasteners **290**A and **2908**. The adjustment shaft **250** and the cam component **270** are integral with each other or otherwise affixed to each other.

Specifically, in the embodiment depicted in FIGS. **9-12**, the adjustment shaft **250** is axially displaced in the direction of arrow E in FIG. **10** by loosening the fasteners **290**A, **290**B by hand; and rotating the cam component **270** in the direction of arrow D in FIG. **10**. FIG. **10** depicts a fully extended or substantially so, position of the adjustment shaft **250**. In order to retract the adjustment shaft **250** into the drain cleaning machine **10**, the fasteners **290**A, **290**B are loosened by hand, and the cam component **270** is rotated in the direction of arrow F in FIG. **11**. Such movement results in axial movement of the adjustment shaft **250** in the direction of arrow G in FIG. **11**. FIG. **11** shows a fully retracted or substantially so, position of the adjustment shaft **250**. The attachment fasteners **290** are adapted to selectively engage one or more corresponding stationary sloped component(s) **280**. As noted, the adjustment shaft **250** and the sloping cam component **270** are integral with each other or affixed to each other. In FIG. **12**, it will be understood that a majority length portion of the adjustment shaft **250** extends into the machine **10**, but is not shown for clarity in describing this embodiment.

The sloping cam component **270** defines one or more guide slots **272** extending arcuately around the adjustment shaft **250**. Each guide slot **272** is sized and shaped to slidingly receive a corresponding stationary sloped component **280**, e.g., **280**A or **280**B. The region of the sloping cam component **270** defining the guide slots **272** extends in a helical fashion about the longitudinal axis of the adjustment shaft **250**.

Each of the stationary sloped components, e.g., **280**A, **280**B, includes a distal sloped face **282**. Thus, component **280**A includes a distal sloped face **282**A and component **280**B includes a distal sloped face **282**B as shown in FIG. **12**.

The assembly **220** may optionally comprise corresponding bushings **285**, i.e., bushings **285**A and **285**B which are configured to be slidably disposed within the corresponding guide slots **272**. As shown in FIG. **12**, each bushing defines a flat front face **286** for engaging a corresponding fastener **290** and an oppositely directed sloped face **287** for engaging a sloped distal face **282** of a corresponding stationary sloped component **280**.

Another such means of tool-less clutch adjustment is by use of an assembly having an adjustment shaft with discrete axial steps to engage fixed height bosses on the stationary element, as shown in FIGS. **13-16**. By loosening the hand-driven fasteners, the adjustment shaft could be manually rotated and simultaneously pushed or pulled to engage a different axial step against the stationary boss(es) to result in a different axial linear position of the adjustment shaft. Again, the clutch is compressed or expanded based on the adjustment shaft linear axial position. The position of the adjustment shaft can then be locked via hand fasteners between the adjustment shaft and the fixed stationary member(s).

Referring to FIGS. **13** to **16**, a portion of a drain cleaning machine **10** with an adjustable clutch assembly **320** is depicted. The clutch assembly **320** comprises the previously described assembly of clutch cones and clutch members. In the embodiment of FIGS. **13** to **16**, the noted assembly **320** comprises an adjustment shaft **350**, a cam component **370**, one or more stationary bosses **380** such as stationary bosses **380**A and **3806**, and one or more attachment fasteners **390** such as fasteners **390**A and **390**B. The adjustment shaft **350** and the cam component **370** are integral with each other or otherwise affixed to each other.

Specifically, in the embodiment depicted in FIGS. **13-16**, the adjustment shaft **350** is axially displaced in the direction of arrow I in FIG. **14** by loosening the fasteners **390**A, **390**B by hand; and rotating the cam component **370** in the direction of arrow H in FIG. **14**. FIG. **14** depicts a fully extended or substantially so, position of the adjustment shaft **350**. In order to retract the adjustment shaft **350** into the drain cleaning machine **10**, the fasteners **390**A, **390**B are loosened by hand, and the cam component **370** is rotated in the direction of arrow J in FIG. **15**. Such movement results in axial movement of the adjustment shaft **350** in the direction of arrow K in FIG. **15**. FIG. **15** shows a fully retracted or substantially so position of the adjustment shaft **350**. The attachment fasteners **390** are adapted to selectively engage corresponding stationary bosses **380**. As noted, the adjustment shaft **350** and the cam component **370** are integral with each other or affixed to each other. In FIG. **16**, it will be understood that a majority length portion of the adjustment shaft **350** extends into the machine **10**, but is not shown for clarity in describing this embodiment.

The cam component **370** defines one or more guide slots **372** extending arcuately around the adjustment shaft **350**. Each guide slot **372** is sized and shaped to slidingly receive a corresponding stationary boss **380**, e.g., **380**A or **380**B. The region an outer face of the cam component **370** defining the guide slots **372** extends in a stepped fashion about the longitudinal axis of the adjustment shaft **350**. That is, the cam component **370** defines a plurality of steps **375** which are depicted as steps **375**A, **375**B, **375**C, etc. The steps **375** are located adjacent or near the guide slot **372**. Each step has a different height as compared to an adjacent step. And, the steps are arranged along the guide slot **372** such that the steps progressively increase in height or progressively decrease in height. The present subject matter includes a plurality of collections of progressively increasing/decreasing steps. For example, the referenced figures illustrate two collections of progressively increasing/decreasing steps.

Each of the stationary bosses, e.g., **380**A, **380**B, includes a distal flat face **382**. Thus, boss **380**A includes a distal flat face **382**A and boss **380**B includes a distal flat face **382**B.

Yet another way to adjust clutch position is by use of an assembly having provisions for shifting the opposite side of the clutch joint as compared to all the embodiments described herein. In this assembly, a knob or other member integrated into the primary clutch actuation device, e.g., pivoting handle, is rotated or otherwise moved such as shown in FIG. **17**. An in-line worm gear, then, simultaneously turns and creates rotation to a perpendicular pinion shaft, which translates its rotational motion to linear axial travel to the adjustment shaft via a gear rack profile. This axial travel results in the clutch cones compressing the clutch, changing the clamp diameter of the clutch mechanism. After adjustment of the clutch, the actuation handle is moved, rotated, or otherwise displaced to induce the typical clutch engagement to the rotating drain cleaning cable. This movement of the actuation handle is transmitted through the non-rotating worm gear into the pinion shaft.

Another variation of the above noted assembly is to directly rotate the pinion shaft by hand to move the adjustment shaft and vary the clutch cone position in the clutch assembly. In this version, the drive mechanism between the actuation handle and the pinion shaft is disconnected during clutch adjustment to allow the handle to remain stationary while the adjustment occurs. This could be accomplished by a spline engagement between the pinion and handle that would be disengaged when adjustment is desired, then re-engaged during normal machine operation.

Specifically, referring to FIGS. **17-20**, a portion of a drain cleaning machine **10** with an adjustable clutch assembly **420** is shown. The clutch assembly **420** comprises the previously described assembly of clutch cones and clutch members. In the embodiment of FIGS. **17-20**, the noted assembly comprises an adjustment shaft **450**, a pinion shaft **460**, a clutch actuation handle **415**, and a clutch adjustment member **406** with a worm gear **407**. It will be understood that the adjustment shaft **450** is located on an opposite side of the clutch cones **430** and clutch members **440** as compared to the previously described adjustment shafts **50**, **150**, **250**, and **350**. The adjustment shaft **450** and its location is similar to the adjustment shaft **550** and its location depicted in FIGS. **23** and **25**. The adjustment shaft **450** defines a proximal end and an opposite distal end. The proximal end of the adjustment shaft **450** is adjacent the clutch cones **430**. The adjustment shaft **450** defines a hollow interior extending between the proximal and distal ends. The adjustment shaft **450** also defines a longitudinal axis. The actuation handle **415** includes a base **416** defining a passage **417** sized and shaped to receive the pinion shaft **460**. The machine **10** includes a housing or frame portion **435** that also defines a passage **436** sized and shaped to receive the pinion shaft **460**. Upon assembly, the passages **417** and **436** are aligned and the pinion shaft **460** inserted in the aligned passages **417** and **436**. Depending upon the axial position of the pinion shaft **460**, the actuation handle **415** can be pivoted or otherwise displaced about the longitudinal axis of the pinion shaft **460**. These aspects are described in greater detail herein.

The actuation handle **415** includes a receptacle **418** in the base **416**. The receptacle **418** is sized and shaped to receive the clutch adjustment member **406**. In the particular version shown in the referenced figures, the clutch adjustment member **406** includes a worm gear **407** and a knob or handle member **405**.

When the clutch adjustment knob **405** is rotated, the worm gear **407** rotates and imparts rotation through a worm wheel **462** to the pinion shaft **460**. As the pinion shaft **460** rotates, the adjustment shaft **450**, with clutch cone(s) attached, is linearly translated, modifying the gap between the clutch cones and, therefore, reducing or enlarging the clutch opening for different cable sizes. When the operator uses the sectional drain cleaner **10**, the user rotates or moves the clutch actuation handle **415**. When the handle **415** is rotated or moved downward to the position shown in FIG. **17**, the gear teeth of the worm gear **407** remain in contact with the worm wheel **462** of the pinion shaft **460**, thereby causing the worm wheel **462** and pinion shaft **460** to rotate. This rotation of the pinion shaft **460** linearly translates the adjustment shaft **450** and clutch cone(s) to reduce the clutch cone gap, thereby causing the clutch jaw spacing to reduce and make contact with the cable, imparting rotation to the cable for proper drain cleaning.

In a variant version, the pinion shaft **460** can be selectively disengaged from the actuation handle **415**. In this version, schematically depicted in FIGS. **19** and **20**, a pinion shaft **460** includes two lengthened cylindrical areas with male splines **461** and gear teeth that engage the adjustment shaft gear rack. A representative gear rack is described herein in association with FIGS. **23** and **25** and shown in those figures as gear rack **555**. Bushings **402** in the housing **435** support a section of the cylindrical surfaces of the pinion shaft **460**. And the male splines **461** of the pinion shaft **460** engage female splines **418** in the actuation handle **415**. When the handle **415** is engaged to the adjustment shaft **460**, rotation of the handle **415** translates the adjustment shaft **450** linearly via the gear teeth of the pinion shaft **460** and the gear rack profile in the adjustment shaft **450**. If the pinion shaft **460** is pulled axially outward in the direction of arrow L in FIG. **19**, this disengages the actuation handle **415** from the adjustment shaft **450**. Thus, the female splines **418** of the actuation handle **415** are no longer in contact with the male splines **461** of the pinion shaft **460**. In this fashion, a knob or lever mounted to the pinion shaft **460** can be used by the user to rotate the pinion shaft **460** such as in the direction of arrow M shown in FIG. **20**, thereby extending or retracting the adjustment shaft **450** linearly via the gear teeth that remain meshed, without affecting the position of the actuation handle **415**. Thus, the pinion shaft **460** is selectively displaceable between (i) a free position in which rotation of the pinion shaft **460** is independent of the position of the handle **415**, and (ii) an engaged position in which rotation of the pinion shaft **460** is dependent upon the position of the handle **415**. When the pinion shaft **460** is in the free position, rotation of the pinion shaft **460** causes linear displacement of the gear rack and adjustment shaft **450**. Similarly, when the pinion shaft **460** is in the engaged position, rotation of the pinion shaft **460** causes linear displacement of the gear rack and adjustment shaft **450**. Thus, rotation of the pinion shaft **460** causes linear displacement of the gear rack and adjustment shaft regardless of the pinion shaft being in the free or engaged position. Specifically, FIG. **19** shows the pinion shaft **460** in the engaged position, i.e., position (ii). And, FIG. **20** shows the pinion shaft **460** in the free position, i.e., position (i). The housing bushings **402** continue to support the pinion shaft **460** on the extended cylindrical surfaces. The splines **461** around the entire circumference of the pinion shaft **460**, and in the mating bore **417** of the actuation handle **415**, allow the pinion shaft **460** to be reinserted to the first axial position when the desired clutch setting position is achieved.

Clutch Removal

During normal operation, the operator actuation device, for example a clutch actuation handle **515**, is moved or otherwise rotated downward to engage the clutch onto the rotating component, for example a drain cleaning cable, as shown in FIG. **21**. When the operator removes input from the actuation handle **515**, the spring-loaded handle **515** will disengage the clutch from the rotating drain cleaning cable. The position of the actuation handle can be limited by a fixed object, which in this embodiment, can be in the form of a selectively positionable limit pin **580**, as shown in FIGS. **21-22**. When the adjustment shaft is shifted or linearly displaced furthest away from the actuation handle and the top cover of the machine is removed, the selectively positionable limit pin **580** is also retracted or removed and the actuation handle **515** can then be positioned beyond the normal operating stop. In this case, the clutch system accommodates additional axial linear travel, sufficient to separate the clutch cones to thereby allow the clutch member(s) to be removed from between the clutch cones that typically hold the clutch member(s) in place, as shown in FIG. **24** and FIG. **25**.

During clutch replacement, a new clutch or clutch member(s) can be placed in the gap between the clutch cones, and the actuation handle **515** moved or rotated to hold the clutch in position while the top cover is reinstalled. Again, the top cover with the noted limit pin **580** will allow normal operation without loss of the clutch from its operating position.

Specifically, in this embodiment shown in FIGS. **21-25**, a drain cleaning machine **10** is provided with an adjustable clutch assembly **520**. The clutch assembly **520** comprises the previously described assembly of clutch cones and clutch members. These are shown as clutch members **540** and clutch cones **530**. The clutch assembly **520** also comprises a rotatable or movable actuation handle **515**. The clutch assembly **520** also comprises a linearly displaceable adjustment shaft **550** having a linear gear rack **555** affixed or formed with the adjustment shaft **550**. The adjustment shaft **550** is as the previously described adjustment shaft **450**. The clutch assembly **520** additionally comprises a pinion shaft **560** with gear teeth that engage the gear rack **555**. Upon rotation of the actuation handle **515**, the pinion shaft **560** is rotated, thereby causing linear displacement of the gear rack **555** and the adjustment shaft **550**.

The adjustable clutch assembly **520** also comprises a selectively positionable locking pin assembly **570** that includes a base **572**, a displaceable pin **574**, one or more biasing members **576**, and a receiving aperture **578** defined in the actuation handle **515**. The aperture **578** is sized and shaped to receive the pin **574**. The pin **574** of the pin assembly **570** is positionable between a locked position in which the pin **574** is inserted or disposed in the aperture **578** of the handle **515**; and an unlocked position in which the pin **574** is not disposed in the aperture **578**, thus allowing the handle **515** to be rotated about the longitudinal axis of the pinion shaft **560**. Typically, the pin **574** is moved from the locked position to the unlocked position by pulling or moving the pin **574** in the direction of arrow N in FIG. **22**. Upon positioning the pin **574** to the unlocked position, the handle **515** can be freely moved about the axis of the pinion shaft **560**. The pin assembly **570** typically also includes one or more biasing members **576** which for example can be in the form of a coil spring. The biasing member(s) **576** are configured to urge the pin **574** toward the unlocked position through contact with a stop pin (not shown). A user can move the pin **574** to the locked position by pushing the pin **570** in a direction opposite of arrow N to thereby compress the biasing member **576**, and then turning or rotating the pin **574** about its major axis at which the stop pin (formed or affixed to the pin **574**) is received in a portion of the frame or housing of the machine **10** to thereby retain the pin **574** in the locked position.

Referring to FIGS. **22-25**, upon positioning the pin **574** to the noted unlocked position, and retracting or removing the limit pin **580**, the actuation handle **515** can be further moved in the direction of arrow P, thereby linearly displacing the adjustment shaft **550** in the direction of arrow R. Upon sufficient movement of the adjustment shaft **550**, a clearance span X will be achieved, thereby allowing removal of one or more clutch members **540**. More specifically, it can be seen from the referenced figures that retraction or removal of the limit pin **580** to create clearance region **581** in FIG. **24**, enables the handle **515** to be positioned in the direction of arrow P and thereby allow clutch removal. If the limit pin **580** is not removed to create the clearance region **581** and so the limit pin **580** remains as shown in FIG. **21**, the handle **515** can not be positioned to the position shown in FIGS. **24** and **25**. Instead, the presence of the limit pin **580** precludes further movement of the handle **515** in the direction of arrow P as shown in FIG. **22**.

An advantage of the tool-less clutch adjustment and removal is the efficiency gained by the operator during use. The present subject matter eliminates the need for the user to find a tool that may be misplaced or not available, especially when using the machine on a jobsite. Even if available, accessing and using a tool would cost the user valuable time.

Because the application of the present subject matter is more efficient than currently known techniques and assemblies, operators are more likely to vary drain cleaning cable sizes on jobs, thereby more efficiently and more thoroughly completing the job.

Easily adjusting the clutch, and therefore the actuation device position, means the operator will utilize a more ergonomically-friendly position and optimize the input force they provide to the actuation device.

By easing the means of clutch replacement, better clutch engagement is expected compared to worn components that may traditionally be used beyond recommended life.

In general, the present subject matter could be applied to any application where linear motion is sought via circumferential operator input.

Many other benefits will no doubt become apparent from future application and development of this technology.

All patents, applications, standards, and articles noted herein are hereby incorporated by reference in their entirety.

The present subject matter includes all operable combinations of features and aspects described herein. Thus, for example if one feature is described in association with an embodiment and another feature is described in association with another embodiment, it will be understood that the present subject matter includes embodiments having a combination of these features.

As described hereinabove, the present subject matter solves many problems associated with previous strategies, systems and/or devices. However, it will be appreciated that various changes in the details, materials and arrangements of components, which have been herein described and illustrated in order to explain the nature of the present subject matter, may be made by those skilled in the art without departing from the principle and scope of the claimed subject matter, as expressed in the appended claims.

What is claimed is:

1. An adjustable clutch assembly (**20**) comprising:

a cylindrical sleeve (**70**) defining a hollow interior aligned with a longitudinal axis (A), wherein at least a portion of the hollow interior of the sleeve (**70**) includes a circumferential surface defining a threaded region (**72**);

a plurality of positionable clutch members (**40**A, **40**B) comprising at least one clutch member (**40**A) defining a first engagement face (**42**A) and an associated first ramp region (**44**A), and at least one other clutch member (**40**B) defining a second engagement face (**42**B) and an associated second ramp region (**44**B), wherein the first and second engagement faces (**42**A, **42**B) are spaced apart;

a clutch cone (**30**) defining a cone face (**32**) oriented to operatively engage one of the first and second ramp regions (**44**A, **44**B), for positioning one of the clutch members (**40**A, **40**B) toward the other one of the clutch members (**40**A, **40**B);

a cylindrical adjustment member (**50**) defining a hollow interior (**56**) aligned with the longitudinal axis (A), wherein an external circumferential surface portion of the cylindrical adjustment member (**50**) defines a threaded region (**58**) having threads mating with the threaded region (**72**) of the cylindrical sleeve (**70**), wherein rotation of the cylindrical adjustment member (**50**) in a first direction about the longitudinal axis (A) relative to the sleeve (**70**) causes the cone face (**32**) to be urged toward one of the first and second ramp regions (**44**A, **44**B) for operatively positioning the first and second engagement faces (**42**A, **42**B) of the clutch members (**40**A, **40**B) together; and

a locking clamp (**85**) positionable between a free position at which the cylindrical adjustment member (**50**) is rotatable about the longitudinal axis (A) relative to the cylindrical sleeve (**70**) and a locked position at which the cylindrical adjustment member (**50**) is not rotatable relative to the cylindrical sleeve (**70**),

wherein the locking clamp (**85**) includes a circumferential member (**80**) surrounding at least a portion of the cylindrical adjustment member (**50**), wherein the circumferential member (**80**) defines a first end (**82**) and a second end (**84**), and wherein the locking clamp (**85**) further includes a lever mechanism operatively connected to the circumferential member (**80**) for urging the first end (**82**) and the second end (**84**) together and causing the threaded region (**72**) of the sleeve (**70**) to frictionally engage the threaded region (**58**) of the cylindrical adjustment member (**50**) at a preselected axial position when the locking clamp (**85**) is at the locked position.

2. The clutch assembly of claim **1**, wherein the lever mechanism comprises an over-center lever (**90**).

3. The clutch assembly of claim **1**, wherein further rotation of the cylindrical adjustment member (**50**) about the longitudinal axis (A) in the first direction, causes the cone face (**32**) to contact and slidingly engage the other of the first and second ramp regions (**44**A, **44**B) for further positioning the first and second engagement faces (**42**A, **42**B) of the clutch members (**40**A, **40**B) closer together.

4. The clutch assembly of claim **1**, wherein further rotation of the adjustment member (**50**) about the longitudinal axis (A) in the first direction, causes the cone face (**32**) to contact and slidingly engage both of the first and second ramp regions (**44**A, **44**B) for causing the first and second engagement faces (**42**A, **42**B) to be positioned to operatively contact a drain cleaning cable disposed therebetween.

5. The clutch assembly of claim **1**, wherein the sleeve (**70**) defines at least one circumferential slot (**75**) through a portion of the sleeve (**70**).

6. The clutch assembly of claim **5**, wherein the sleeve (**70**) defines at least one axial slot (**76**) intersecting the at least one circumferential slot (**75**).

7. The clutch assembly of claim **5**, wherein the at least one circumferential slot (**75**) extends along an arc ranging from about 90° to about 270°.

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