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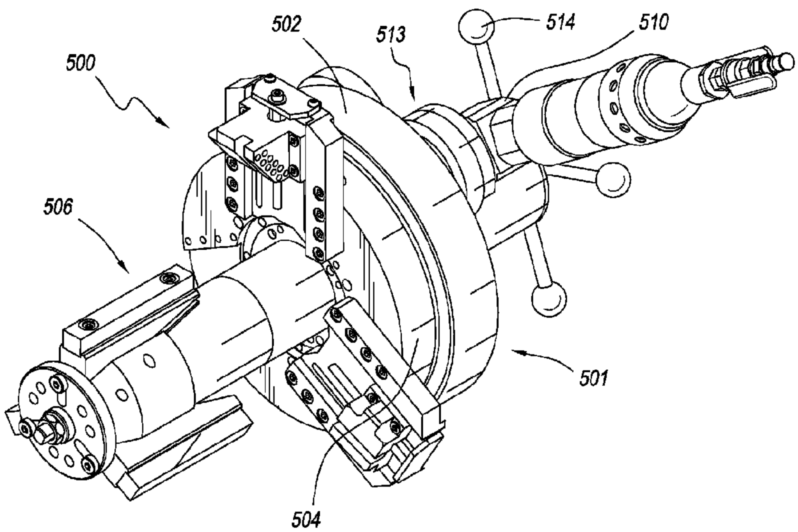

(57) **Abrégé/Abstract:**
A portable lathe machine (500) for machining a work piece includes a support housing (502) adapted for mounting on the work piece and a rotating head (504) rotatably mounted on the support housing (502) about an axis (526). A drive module (510) is arranged to drive rotation of the rotating head (504) about the axis (526). The rotating head (504) defines the internal gear (548) and at least one gear connection is formed between the internal gear (548) and the drive module (510). The at least one gear connection is radially positioned inside an outer diameter of the support housing (502) to protect an operator from a pinch point associated with the at least one gear connection.

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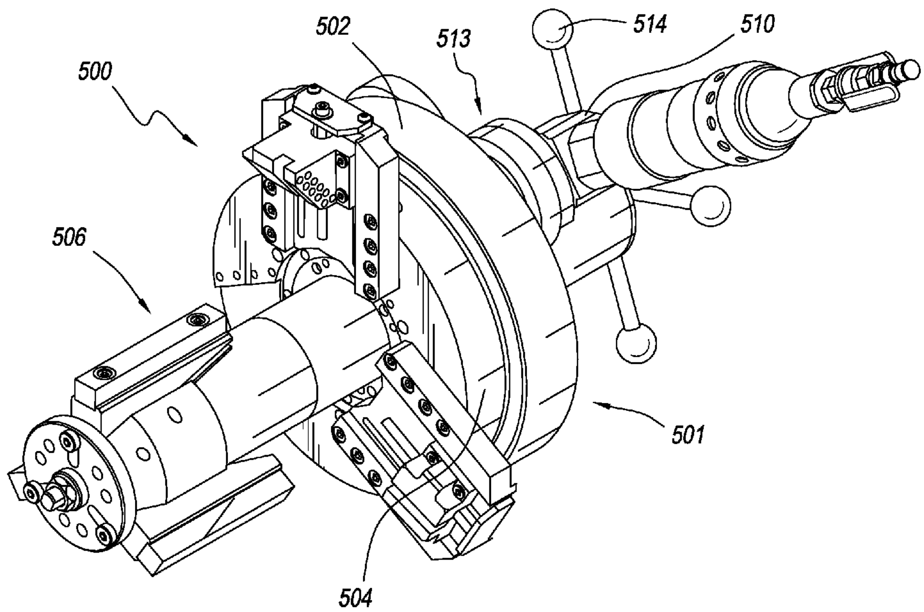

FIG. 20

(57) Abstract: A portable lathe machine (500) for machining a work piece includes a support housing (502) adapted for mounting on the work piece and a rotating head (504) rotatably mounted on the support housing (502) about an axis (526). A drive module (510) is arranged to drive rotation of the rotating head (504) about the axis (526). The rotating head (504) defines the internal gear (548) and at least one gear connection is formed between the internal gear (548) and the drive module (510). The at least one gear connection is radially positioned inside an outer diameter of the support housing (502) to protect an operator from a pinch point associated with the at least one gear connection.

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PORTABLE LATHE MACHINE

[01] TECHNICAL FIELD

[02] The disclosure relates to a portable lathe machine adapted to improve the safety of operators and machining performance.

[03] BACKGROUND

[04] In many applications it is necessary to prepare the end surface of a pipe or tube. For example, pipe sections are often joined together by welding and, as such, the end surface of each pipe section must be properly prepared.

[05] In relation to the preparation of the end surface of pipe sections, portable lathe machines are typically used in the field where use of a fixed lathe machine is not appropriate or possible. Generally, conventional portable lathe machines include a rotary cutting head carrying a cutting tool that is placed adjacent to the end of a pipe and rotated about the pipe with the tool position and/or shape providing the desired configuration of the cut made in the end surface of the pipe. In conventional lathe machines, rotation of the cutting head is driven by spur, helical, or worm style external gear teeth on the cutting head in conjunction with one or more driving pinion or worm gears positioned adjacent to the outside of the machine housing/envelope.

[06] This is problematic because it can expose an operator or other individual, for example, to dangerous pinch points between the driving gears and the cutting head. A "pinch point" is a point that develops when two parts move together and at least one moves in rotary or circular motion. Pinch points commonly cause disabling workplace injuries to fingers, hands, and/or arms of operators or other individuals. It is possible to have a hand, fingers, or an arm of an operator caught in the pipe and tube cutting machine and injured. U.S. Patent 9,138,808 discloses a portable pipe lathe with safety features for protecting operators from pinch points.

[07] SUMMARY

[08] The portable lathe machine of the present disclosure is arranged to improve the safety of operators and machining performance. Embodiments of the portable lathe machine can include a support housing adapted for mounting on the work piece and a rotating head rotatably mounted on the support housing about an axis. A drive module is arranged to drive rotation of the rotating head about the axis.

[09] The rotating head defines an internal gear and at least one gear connection is formed between the internal gear and the drive module. The at least one gear connection is radially positioned inside an outer diameter of the support housing. As such, potential pinch points associated with the at least one gear connection are advantageously positioned radially inside of the lathe machine where an operator is not in danger of injuring a hand or fingers between the rotating head and the drive module.

[10] The internal gear is defined on the rotating head. This beneficially provides improved performance and smoother rotation of the rotating head relative to the support housing by reducing the likelihood of improper alignment between the rotating head and the drive module. This can also beneficially improve the strength and/or rigidity of the internal gear by eliminating a potential failure point between the rotating head and a separate internal gear.

[11] The internal gear of the present disclosure also reduces the overall weight of the lathe machine because the at least one gear connection is formed without the need of additional structural components. Moreover, it does so while also reducing the overall profile of the lathe machine. This advantageously can lessen operator fatigue, making the lathe machine easier and more comfortable to operate. The internal gear also simplifies the construction of the lathe machine, helping to achieve more economical manufacturing cost.

[12] It also advantageously can improve the life of the internal gear. For instance, the internal gear is not a component that operators or other individuals need to remove from the lathe machine for maintenance or inspection. This means they are not repeatedly retightening bolts or other fasteners connecting the internal gear to the rotating head. This is beneficial because the repeated retightening of bolts can result in undesired bolt stretch or slippage in the friction plane between the bolts and the internal gear and/or rotating head, which, in turn, can cause accelerated wear on teeth of the internal gear. The internal gear of the present disclosure thus improves the useful life of the internal gear by preventing or eliminating movement between the internal gear and the rotating head.

[13] According to a variation, the at least one gear connection is located radially between inner and outer radial shoulders of the support housing. This beneficially provides a greater physical and/or solid barrier between the operator and the potential pinch points, reducing the likelihood of injury to the operator. This is in contrast to conventional lathe machines where such gear connections are dangerously and/or awkwardly exposed outside of the support housing and/or the rotating head. The portable lathe machine of the present disclosure is thus safer and lower profile than in the prior art.

[14] According to a variation, the drive module includes first and second gear members arranged to interact at different points of contact with the internal gear of the rotating head. These different points of contact beneficially help stabilize the rotating head as it rotates relative to the support housing and transmits torque, improving machining performance. In addition, the interaction between the internal gear and the first and second gear members is located within and/or concealed by the rotating head and the support housing. Safety of the lathe machine is thus enhanced because the support housing and rotating head limits or eliminates potential pinch points associated with these multiple gear connections. Embodiments of the portable lathe machine can thus reduce the risk of an operator injuring a hand or finger and improve machining performance.

[15] BRIEF DESCRIPTION OF THE DRAWINGS

[16] These and other features, aspects, and advantages of the present disclosure will become better understood regarding the following description, appended claims, and accompanying drawings.

[17] Fig.1 is a front isometric view of a pipe lathe according to an embodiment.

[18] Fig. 2 is a front isometric view of a tool module removed from the pipe lathe in Fig. 1.

[19] Fig. 3 is a bottom view of the tool module in Fig. 2.

[20] Fig. 4 is a back view of the tool module in Fig. 2.

[21] Fig. 5 is a cross-sectional view of the tool module in Fig. 2.

[22] Fig. 6 is an isometric view of a tripper assembly removed from the pipe lathe in Fig. 1.

[23] Fig. 7 is a partial cross-sectional view of the pipe lathe in Fig. 1.

[24] Fig. 8 is a back isometric view of the pipe lathe in Fig.1.

[25] Fig. 9 is another partial cross-sectional view of the pipe lathe in Fig. 1 showing a drive gear assembly according to an embodiment.

[26] Fig. 10 is a front isometric view of a tool module according to another embodiment.

[27] Fig. 11 is a partial cross-sectional view of a pipe lathe showing the tool feed system of a tool module according to another embodiment.

[28] Fig. 12 is a partial cross-sectional view of a pipe lathe showing the tool feed system of a tool module according to another embodiment.

[29] Fig. 13 is a front isometric view of a pipe lathe according to another embodiment.

[30] Fig. 14 is a front isometric view of a tool module removed from the pipe lathe in Fig. 13.

[31] Fig. 15 is a back view of the tool module in Fig. 14.

[32] Fig. 16 is a front isometric view of a tripper assembly removed from the pipe lathe in Fig. 13.

[33] Fig. 17 is a cross-sectional view of the tripper assembly in Fig. 16.

[34] Fig. 18 is another cross-sectional view of the tripper assembly in Fig. 16.

[35] Fig. 19 is a detailed view of the pipe lathe in Fig. 13 showing the tool feed system of the tool module.

[36] Fig. 20 is a front isometric view of a lathe machine according to another embodiment.

[37] Fig. 21 is a side view of the lathe machine in Fig. 20.

[38] Fig. 22 is a front view of the lathe machine in Fig. 20.

[39] Fig. 23 is a front isometric view of the support housing in Fig. 20.

[40] Fig. 24 is a back isometric view of the rotating head in Fig. 20.

[41] Fig. 25 is a back view of the lathe machine in Fig. 20.

[42] Fig. 26 is a cross section view of the lathe machine in Fig. 20.

[43] Fig. 27 is another cross section view of the lathe machine in Fig. 20 showing the drive assemblies according to an embodiment.

[44] Fig. 28 is a side view of a lathe machine according to another embodiment.

[45] Fig. 29 is a front view of a lathe machine according to another embodiment.

[46] DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

[47] A better understanding of different embodiments of the disclosure may be had from the following description read with the accompanying drawings in which like reference characters refer to like elements.

[48] A first exemplary embodiment of a portable lathe machine comprising a pipe lathe 100 is shown in Fig. 1. The pipe lathe 100 includes a support housing 102, a headstock 104, one or more bearing assemblies 106 (shown in Fig. 7) that rotatably mount the headstock 104 to the support housing 102, and a drive module 135 and gear box 147 operatively connected to the headstock 104 to rotate the headstock 104. Both the support housing 102 and the headstock 104 can be segmented (e.g. split into two or more pieces) and designed to be coupled together to form a complete assembly around a work piece (e.g., a pipe) to be machined.

[49] The work piece is supported concentrically by the pipe lathe 100 relative to an axis of rotation 108 of the headstock 104. The pipe lathe 100 can be split diametrically along line 110 with two semicircular halves that are removably fastened. While the pipe lathe 100 is shown including two halves, the pipe lathe 100 can be constructed as four or any other suitable number of segments that may be joined around the work piece. While the pipe lathe 100 is described as being mounted on the exterior perimeter of the work piece, in other embodiments, the pipe lathe 100 can be employed on the interior circumference or perimeter of the work piece. It will also be appreciated that while the pipe lathe 100 is shown having a generally circular shape, the pipe lathe 100 may have an oval shape, a tapered shape, combinations thereof, or any other suitable shape.

[50] The support housing 102 can be a generally annular member adapted to be concentrically clamped about the work piece. The support housing 102 can include two segments 112, 114 (shown in Fig. 1) that are removably coupled together. The first segment 112, which is shown and described as a first half 112 of the support housing 102, can be structured to extend around or within a first portion of the perimeter of the work piece. The second segment 114, which is shown and described as a second half 114 of the support housing 102, can be structured to extend around or within a second portion of the perimeter of the work piece.

[51] The support housing 102 can include a back side 116 (Fig. 8) and a front side 118 disposed opposite the back side 116 of the support housing 102. For proper centering, a plurality of spacers 120 (e.g., feet or pads) can be positioned about the inner interior wall surface of the support housing 102 and held in place by bolts 122.

[52] It will be appreciated that the support housing 102 can exhibit any suitable configuration. For instance, while the support housing 102 is shown comprising two halves, the support housing 102 can be constructed as three, four, or any suitable number of segments that may be joined about the work piece. The support housing 102 can be formed of any suitable material. The support housing 102 can include aluminum or other suitable metals.

[53] The headstock 104 can be mounted for rotation about axis 108 on the support housing 102. The headstock 104 can include a back side 124 (Fig. 7), which faces the front side 118 of the support housing 102, and a front side 126 disposed opposite the back side 124 of the headstock 104. The back side 124 the headstock 104 also can provide a support area for a gear ring described below. The headstock 104 can be formed of medium-carbon alloy steel, carbon steel, stainless steel, tungsten carbide, combinations thereof, or another suitable material. The headstock 104 can exhibit any suitable configuration.

[54] Two tool modules 128, 130 can be mounted on the front side 126 of the headstock 104. Each tool module 128, 130 can be arranged to selectively mount several tool bits for cutting or machining (e.g., beveling, grooving, and/or other operations) the work piece. In the illustrated embodiment, the tool modules 128, 130 are disposed on opposite sides (e.g., diametrically opposite sides) of the headstock 104. Such a configuration can help create a neutral cutting force, whereby binding or twisting of the pipe lathe 100 can be avoided or minimized. While two tool modules are described and illustrated, it will be appreciated that the pipe lathe 100 can include any suitable number of tool modules.

[55] At least one of the tool modules 128, 130 includes a tool feed system 181 (shown in Fig. 5) that causes advancement of the tool module towards or away from the surface of the work piece while eliminating or limiting pinch points. The tool feed system 181 can exhibit any suitable configuration. For simplicity of illustration and economy of disclosure, only one tool module 128 will be described. It will be appreciated, however, that the other tool module 130 may be substantially similar to or different than the tool module 128. For instance, the tool module 130 can have a lower profile module than the tool module 128. By way of another example, the tool module 128 may be radially adjustable as described below and the tool module 130 may not be radially adjustable.

[56] Figs. 2-5 illustrate the tool module 128 removed from the pipe lathe 100 for ease of reference. As seen in Figs. 2 and 3, the tool module 128 can include a block member 132. The block member 132 can include a planar front side 144 and a generally planar back side 146 (shown in Fig. 3) disposed opposite the front side 144 of the block member 132. The back side 146 of the block member 132 faces the front side 126 of the headstock 104. The block member also can include a planar bottom side 148 and a curved top side 150 disposed opposite the bottom side 148 of the block member 132.

[57] The block member 132 can include a plurality of apertures 152 for receiving a plurality of fasteners 154 (shown in Fig. 1) to fasten the block member 132 to the headstock 104. The apertures 152 can be patterned in the block member 132 such that the radial position of the tool module 128 including a tool holder 134 can be adjusted relative to the axis 108 by inserting the fasteners 154 in different apertures 152. It will be appreciated that the block member 132 can include any suitable number and/or pattern of apertures. As discussed in more detail below, the position of the tool module 128 can be adjustable while keeping the tool feed system of the tool module 128 engaged with a tripper pin positioned under the tool block.

[58] The front side 144 of the block member 132 can include a front cavity 156 defined by a top wall 158 and a pair of sidewalls 160 extending between the top wall 158 and the bottom side 148 of the block member 132. A cutout 162 (Fig. 4) can be formed in the top side 150 of the block member 132. The cutout 162 can be at least partially defined by a bottom wall 164 and a pair of side walls 166 extending between the bottom wall 164 and the top side 150.

[59] A through-hole 161 (Fig. 5) can extend through the bottom wall 164 of the cutout 162 into the front cavity 156. A top support bracket 186 can be positioned in the cutout 162 that includes a first hole aligned with the through-hole extending through the bottom wall 164 of the cutout 162 and a second hole generally aligned with a slot described below.

[60] As best seen in Figs. 2 and 3, a pair of guides 168 including grooves 170 facing one another can be removably mounted in the front cavity 156 of the block member 132. The grooves 170 can exhibit any suitable configuration. The grooves 170 have a V-shaped cross-section. In other embodiments, the grooves 170 can be angular, trapezoidal, curved, combinations thereof, or any other suitable shape.

[61] A base member 172 can be slidably positioned between the guides 168. The base member 172 can include a front side 174, a back side 176, and opposite sidewalls 178 extending between the front side 174 and the back side 176. The sidewalls 178 can be arranged to correspond to the grooves 170 in the guides 168. Engagement between the sidewalls 178 and the grooves 170 in the guides 168 can create a sliding contact surface that permits the base member 172 to travel up and down between the guides 168.

[62] The base member 172 can include a longitudinal groove 180 extending along the back side 176 of the base member 172 between the top and bottom of the base member 172. The longitudinal groove 180 is arranged to slidably receive a feed screw described below. The base member 172 can include a slot 182 (shown in Fig. 5) that traverses the longitudinal groove 180. The slot 182 is arranged to at least partially receive a feed nut described below.

[63] A tool holder 134 can be removably attached to the front side 174 of the base member 172. The tool holder 134 is moved with the base member 172 in the radial direction relative to the work piece and includes an opening to receive and securely hold a tool bit (not shown).

[64] A feed screw 136 can be at least partially in the cutout 162 and the front cavity 156 of the block member 132. The feed screw 136 includes a shaft portion 190 and a first connecting gear 138 including teeth. The shaft portion 190 extends through the longitudinal groove 180 of the base member 172. The first connecting gear 138 can be fixedly connected to the shaft portion of the first connecting gear 138. The first connecting gear 138 can be positioned within the cutout 162 of the block member 132 and over the bracket 186. At least a portion of the shaft portion 190 can be threaded.

[65] Optionally, the feed screw 136 can include a flange or collar portion 194 positioned between the bracket 186 and the bottom wall 164 of the cutout 162. The collar portion 194 can be configured to help maintain the position of the feed screw 136 relative to the block member 132.

[66] Referring to Figs. 4 and 5, a feed nut 196 runs along the feed screw 136 and is operatively coupled to the tool holder 134 so rotation of the feed screw 136 results in radial or up and down translation of the tool holder 134. The feed nut 196 can be threadedly attached to the shaft portion 190 of the feed screw 136 and adapted to ride up and down on the threads of the shaft portion 190 when the feed screw 136 rotates.

[67] The feed nut 196 can be at least partially received within the slot 182 on the back of the base member 172. The connection is formed between the base member 172 and an upper and/or lower surface area of the feed nut 196 such that rotation of the feed screw 136 causes the feed nut 196 to ride up and down on the threads of the shaft portion 190, which moves the base member 172 and tool holder 134 up and down within the front cavity 156.

[68] The connection between the feed nut 196 and the base member 172 can be internalized. This connection or potential pinch point is safely positioned under the base member 172 removing a potentially dangerous pinch point found in the tool feeding systems of conventional tool modules.

[69] The back side 146 of the block member 132 can include a back cavity 198 and a slot 101 extending between the back cavity 198 and the cutout 162 in the top side 150 of the block member 132. A tripper shaft 142 can be positioned in the cutout 162, the back cavity 198, and the slot 101 of the block member 132. The tripper shaft 142 can include a shaft portion 103 and a second connecting gear 140 including teeth. The shaft portion 103 can extend through the second hole in the top support bracket 186 and can be at least partially positioned within the slot 101 and the back cavity 198.

[70] The second connecting gear 140 can be attached to the shaft portion 103 and positioned in the cutout 162 in the top side 150 of the block member 132. The teeth of the second connecting gear 140 are interacted or mesh with the teeth of the first connecting gear 138 on the feed screw 136. Rotation of the tripper shaft 142 rotates the second connecting gear 140, which rotates the first connecting gear 138, which rotates the feed screw 136.

[71] A gear cover 188 can be attached to the top side 150 of the block member 132. The gear cover 188 can be positioned over the first connecting gear 138 and the second connecting gear 140. The first connecting gear 138 and the second connecting gear 140 can be internalized or positioned under the gear cover 188, removing or limiting exposure to the pinch point associated with the interaction between the first connecting gear 138 and the second connecting gear 140. This has the effect of preventing a finger or hand from being caught in between the first connecting gear 138 and the second connecting gear 140, increasing operator safety.

[72] Optionally, the gear cover 188 can include an aperture aligned with a slot formed in the top of the second connecting gear 140. The slot can be configured to receive a tool member (e.g., a hex-wrench) such that an operator can insert a tool member in the slot to manually rotate the tripper shaft 142 as desired.

[73] A feed mechanism 184 comprising a tripper sprocket including teeth 115 can be arranged to cooperate with a fixed tripper pin (described below) to cause advancement of the tool holder 134 towards or away from the surface of the work piece when the headstock 104 is rotated relative to the support housing 102. A bore in the tripper sprocket 184 can be arranged to substantially match the shape of at least a portion of the shaft portion 103 of the tripper shaft 142, which in the illustrated embodiment is square shaped. While the bore in the tripper sprocket 184 is described having a square shape, the bore can have a hexagonal shape, an oval shape, a triangular shape, combinations thereof, or any other suitable shape.

[74] The position of the tripper sprocket 184 along the shaft portion 103 can be adjustable since the tripper sprocket 184 is arranged to slide on the shaft portion 103. No matter where the tripper sprocket 184 is on the axis of the shaft portion 103, the bore of the tripper sprocket 184 can mate with the shaft portion 103 and rotate the tripper shaft 142 when the tripper sprocket 184 rotates.

[75] As discussed in more detail below, a contact point between a tripper pin described below and the tripper sprocket 184 can be maintained even as the tripper sprocket 184 floats up and down on the tripper shaft 142 with radial adjustments of the tool module 128 or tool module 130. To adjust the position of the tool module 128 for a smaller work piece or pipe, the fasteners 154 (shown in Fig. 1) can be removed from the block member 132 to detach the tool module 128 from the headstock 104 and the tool module 128 can be moved radially inward relative to the work piece.

[76] As the tool module 128 is adjusted radially, the position of the tripper sprocket 184 can be maintained within a recess formed in the headstock 104 described below as the tripper sprocket 184 moves along the tripper shaft 142 until the tool module 128 is in a desired position and re-attached to the headstock 104 via the fasteners 154. Further, this allows the location of a collision point between the tripper sprocket 184 and a tripper pin described below to be repositioned relative to the tool module 128 rather than being fixed relative to the tool module as in the prior art, facilitating adjustment of the collision point to better protect an operator from a pinch point associated with the collision point.

[77] A bottom support bracket 192 can be attached to the block member 132 within a bracket slot. The bottom support bracket 192 can be arranged to help retain the tripper sprocket 184 on the tripper shaft 142.

[78] A tripper assembly 105 can be arranged to interact with the tripper sprocket 184. Fig. 6 illustrates the tripper assembly 105 removed from the pipe lathe 100 for ease of reference. The tripper assembly 105 can include a tripper housing 107 having a mounting portion 109 (shown in Fig. 7) and a shaft portion 111. The tripper assembly 105 can include a tripper element 113 comprising a tripper pin mounted to the tripper housing 107. The tripper pin 113 can be provided a fixed impact or contact point between the tripper sprocket 184 and the tripper pin 113 such that upon each complete revolution of the tool module 128, the tripper pin 113 engages a tooth on the tripper sprocket 184 to rotate the tripper sprocket 184 a fraction of a turn, causing rotation of the tripper shaft 142. The tripper pin 113 can be removably mounted in the tripper housing 107 such that the tripper pin 113 can be removed from the tripper housing 107 for replacement and/or repair.

[79] As seen in Fig. 7, the tripper assembly 105 can be mounted in the support housing 102 of the pipe lathe 100. The tripper assembly 105 can be mounted to the support housing 102 in any suitable manner. The tripper assembly 105 can extend axially from the back side 116 of the support housing 102 to the headstock 104 such that the tripper assembly 105 is positioned and configured to actuate the tripper sprocket 184 or another suitable feed mechanism.

[80] The support housing 102 can include one or more bores (not shown) extending therethrough that are arranged for mounting the tripper assembly 105 inside the pipe lathe 100. Referring briefly to Fig. 8, one or more tripper assemblies 105 can be inserted into one or more of the bores such that the one or more tripper assemblies 105 extend generally axially between the back side 116 of the support housing 102 and the headstock 104.

[81] The mounting portion 109 of the tripper housing 107 can be received within a countersunk portion of the bore. The shaft portion 111 of the tripper housing 107 can extend through the bore toward the front side 118 of the support housing 102 such that a portion of the tripper pin 113 protrudes beyond the front side 118 of the support housing 102 toward the headstock 104. The position of the tripper pin 113 is such that the tripper pin 113 can strike the tripper sprocket 184 as the tool module 128 orbits around the axis 108 (shown in Fig. 1).

[82] Because the tripper assembly 105 is positioned within the bore in the support housing 102, the tripper assembly 105 can be substantially concealed within the body or envelope of the pipe lathe 100. The body of the pipe lathe 100 can protect the tripper assembly 105 from

accidental contact by an operator that could injure the operator or inadvertently damage the tripper pin 113. The tripper assembly 105 can be fastened to the support housing 102 via a plurality of fasteners (not shown) that extend through apertures in the mounting portion 109 of the tripper housing 107 and the countersunk portion of the bore.

[83] An annular recess 117 can be formed in the back side 124 of the headstock 104 that is configured to accommodate a portion of the tripper sprocket 184 and the portion of the tripper pin 113 extending beyond the front side of the support housing 102. The recess 117 can comprise an annular groove in the back side 124 of the headstock 104 bound by a pair of sidewalls, a top wall extending between the sidewalls, and the front side 118 of the support housing 102.

[84] When the tool module 128 is mounted on the headstock 104, the collision or contact point between the tripper sprocket 184 and the tripper pin 113 can be located or maintained within the recess 117. Because this contact point is internalized or safely radially positioned inside of the outer diameter 104A (shown in Figs. 1 and 7) of the headstock 104 or within the envelope of the pipe lathe 100, the pipe lathe 100 can protect the operator from a potentially dangerous pinch point associated with contact point. The risk of an operator or other person getting a finger or hand caught in between the tripper pin 113 and the tripper sprocket 184 is limited or eliminated, making the pipe lathe 100 safer to operate.

[85] Further, the collision or contact point between the tripper pin 113 and the tripper sprocket 184 can be maintained in the recess 117 even as the tripper sprocket 184 floats up and down on the tripper shaft 142 with radial adjustments of the tool module 128 or tool module 130. The position of the tripper pin 113 can be fixed and concealed within the recess 117. In contrast to conventional pipe lathes that require radial adjustment of both the tool module and the tripper assembly on a tripper tower to maintain the contact point between the tripper pin and the tripper sprocket, the position of the tool module 128 or 130 can be adjusted radially relative to a fixed position tripper pin 113 safely positioned within the pipe lathe 100.

[86] The operation of the tool module 130 according to an embodiment will now be described. Upon each complete revolution of the tool module 130, the tripper pin 113 engages a tooth on the tripper sprocket 184 within the recess 117 to rotate the tripper sprocket 184 a fraction of a turn, causing rotation of the tripper shaft 142. The tripper pin 113 strikes the tripper sprocket 184 radially inside of the outer diameter 104A of the headstock 104. For instance, the tripper pin 113 can strike the tripper sprocket 184 inside of the headstock 104 such that the headstock 104 protects the operator from a pinch point associated with the collision point or interaction between the tripper pin 113 and the tripper sprocket 184. The risk or threat of an operator getting a hand or finger injured at the contact point of the tripper pin 113 and the tripper socket 184 is removed.

[87] The tripper sprocket 184 can include six teeth 115 (shown in Fig. 4) circumferentially distributed about the tripper sprocket 184. The tripper sprocket 184 is configured such that every time the tripper pin 113 strikes the tripper sprocket 184, the tripper sprocket 184 rotates one tooth 115 or about sixty (60) degrees (e.g., 360 degrees divided by 6 teeth). The tripper sprocket 184 can include many suitable teeth and/or be configured to rotate any suitable number of degrees per contact with the tripper pin 113. The tripper sprocket 184 can be configured to rotate between about 20 degrees and about 180 degrees, about 30 degrees and about 120 degrees, about 36 degrees and about 90 degrees, or about 45 degrees and about 60 degrees.

[88] While in the illustrated embodiment one tripper assembly 105 is shown, in other embodiments, the pipe lathe 100 can include two, three, or any other suitable number of tripper assemblies. In an embodiment, the pipe lathe 100 can include two tripper assemblies diametrically opposed on the support housing 102 such that every time the tool module 128 and/or tool module 130 completes a revolution about the axis 108 or work piece, the tripper sprocket 184 rotates two teeth 115 as it will advance and strike one tripper pin and then hit another tripper pin.

[89] The tripper shaft 142 is attached to the second connecting gear 140 so rotation of the tripper shaft 142 causes rotation of the second connecting gear 140. The second connecting gear 140 meshes with the first connecting gear 138 so rotation of the second connecting gear 140 causes rotation of the first connecting gear 138. The gear cover 188 is positioned over the first connecting gear 138 and the second connecting gear 140, eliminating a potentially dangerous pinch point between the first connecting gear 138 and the second connecting gear 140. The first connecting gear 138 is attached to the feed screw 136 so rotation of the first connecting gear 138 causes rotation of the feed screw 136.

[90] The feed screw 136 is threadedly attached to the feed nut 196 so rotation of the feed screw 136 causes the feed nut 196 to advance up and down along the feed screw 136. The interaction between the feed screw 136 and the feed nut 196 is below the base member 172, eliminating or limiting exposure to a potentially dangerous pinch point between the feed screw 136 and the feed nut 196.

[91] The feed nut 196 is operatively coupled to the tool holder 134 so rotation of the feed screw 136 results in radial movement (e.g., up and down translation) of the tool holder 134. The movement of the tool holder 134 moves the tool bit (not shown) radially deeper into the work piece about which the tool bit is orbiting. The pipe lathe 100 can be substantially or completely free of pinch points associated with the tool feed systems of the tool modules 128 and/or 130.

[92] Optionally, the pipe lathe 100 can include one or more pull-away rotation safety features. The fasteners coupling the segments of the headstock 104, the adjustment fasteners or screws of the tool modules 128, 130, the fasteners retaining the tool bits, and/or other hardware can be arranged such that if the headstock 104 became inadvertently energized, rotation of the headstock 104 would move such hardware away from the operator reducing the chance of injury to the operator due to being caught between rotating elements and any external obstructions when using hand tools at these locations.

[93] The pipe lathe 100 can include one or more features to help enhance safety by eliminating or limiting pinch points associated with a drive system of the pipe lathe. As seen in Figs. 8 and 9, the back side 116 of the support housing 102 can include an outer annular shoulder 127 that provides a space and support area for a gear ring described below. The front side 118 of the support housing 102 can include an inner annular shoulder 129 that provides a space and support area for the bearing assemblies 106.

[94] A separate gear ring 131 can be fastened to the back side 124 of the headstock 104. The gear ring 131 can include a plurality of teeth, the teeth being formed on an inner radial surface of the gear ring 131. While the teeth are described as being on the inner radial surface of the gear ring 131, it will be appreciated that the teeth can be formed on the outer radial surface, the inner radial surface, the top surface, the bottom surface, combinations thereof, or any other surface(s) suitable to cooperate with the drive gear described below.

[95] The gear ring 131 can include a plurality of apertures arranged for receiving a plurality of fasteners to fasten the gear ring 131 to the headstock 104. The gear ring 131 rotates with the headstock 104, but not independently with respect thereto. It will be appreciated that the gear ring 131 can include a plurality of segments. In the illustrated embodiment, the gear ring 131 includes a first segment and a second segment, although it should be appreciated that it could have three or more segments (not shown). While the gear ring 131 is shown and described as being separate from the headstock 104, in other embodiments, the gear ring 131 may be integral to the headstock 104.

[96] The gear ring 131 can be operatively connected to a drive module 135 that rotates the gear ring 131 and the headstock 104 during operation of the pipe lathe 100. The drive module 135 can include a drive motor 137, a first drive shaft 139, a first connecting gear 141, a second connecting gear 143, a second drive shaft 145, and a drive gear 151. The drive motor 137 may be air driven, hydraulically driven, or electrically driven. The drive motor 137 can be mounted to the support housing 102 such that the drive motor 137 forms a right-angle point of entry relative to the back side 116 of the support housing 102.

[97] The drive motor 137 can be mounted to the support housing 102 such that the drive motor 137 forms a non-right angle relative to the back side 116 of the support housing 102. The drive motor 137 can be pivotally mounted on the support housing 102 such that the point of entry of the drive motor 137 relative to the back side 116 can vary along a pre-selected arc (e.g., between about 45 degrees and about 90 degrees). This can facilitate mounting the pipe lathe 100 and/or drive motor 137 in restrictive mounting environments.

[98] The drive motor 137 can be attached to the first drive shaft 139 positioned within a gear box or housing 147. Operation of the drive motor 137 causes rotation of the first drive shaft 139. The first drive shaft 139 can be attached to the first connecting gear 141. The first connecting gear 141 can include a plurality of teeth also within the housing 147 and arranged to interact with the first drive shaft 139 such that rotation of the first drive shaft 139 causes rotation of the first connecting gear 141.

[99] The second connecting gear 143 includes a plurality of teeth arranged to interact or mesh with the teeth of the first drive connecting gear. Rotation of the first drive shaft 139 rotates the first connecting gear 141, which rotates the second connecting gear 143. The second connecting gear 143 can be attached to the second drive shaft 145, which extends parallel to the first drive shaft 139 and into a mounting bore formed in the support housing 102.

[100] Both of the second drive shaft 145 and the second connecting gear 143 can be located inside of one or more portions of the housing 147. Further, the interaction between the first connecting gear 141 and the second connecting gear 143 can be within the housing 147. The safety of the pipe lathe 100 can be enhanced because any pinch point associated with the first and second drive connecting gears is limited or eliminated. The risk of the operator injuring a hand or fingers is reduced.

[101] A mounting bore in the support housing 102 can extend between the back side 116 of the support housing 102 and a point below the inner annular shoulder 129 of the support housing 102. The drive gear 151 can include a plurality of teeth and can be attached to the second drive shaft 145 within the support housing 102. The support housing 102 can include an opening formed in a sidewall portion extending upward from the outer annular shoulder 127 in communication with the mounting bore.

[102] At least a portion of the teeth of the drive gear 151 can extend through the opening such that the teeth of the drive gear 151 can be positioned and configured to interact or mesh with the teeth of the gear ring 131. Rotation of the first drive shaft 139 rotates the first connecting gear 141, which rotates the second connecting gear 143, which rotates the second drive shaft 145, which rotates the drive gear 151, which rotates the gear ring 131, which rotates the headstock 104.

[103] As seen in Fig. 9, the gear connections of the pipe lathe 100 can be situated inside of the pipe lathe 100 or the housing 147. Potential pinch points between the respective gear connections of the drive module 135 and the head stock 104 are inside of the pipe lathe 100 where an operator is not in danger of injuring a hand or fingers between the drive gear 151 and the gear ring 131. Such a configuration is in contrast to conventional pipe lathes where such gear connections are dangerously and awkwardly exposed outside of the support housing 102 and/or headstock 104.

[104] Because the drive gear 151 is mounted inside the pipe lathe 100 or on the back side 116 of the support housing 102 and the tool feed systems of the tool modules 128, 130 are located inside or substantially adjacent an outer surface of the pipe lathe 100 or on the front side 126 of the headstock 104, substantially the entire outer diameter 104A (shown in Fig. 1) of the pipe lathe 100 can be relatively free of pinch points or other obstacles that could injure an operator, improving operator safety. Because there are little or no obstructions associated with the outer diameter 104A of the headstock 104, potential pinch points between such obstructions and the tool modules are eliminated or reduced.

[105] The pipe lathe 100 can include any suitable drive module 135 and/or gear ring 131. For example the drive module 135 can include bevel gear sets, straight cut miter gear sets, skew bevel gears, helical gear sets, spiral bevel gear sets, combinations thereof, or any other suitable gear configuration.

[106] A second exemplary embodiment of a portable lathe machine comprising a pipe lathe 200 is shown in Figs. 10 and 11. The pipe lathe 200 can include a support housing 202 and a headstock 204 rotatably mounted to the support housing 202. It will be appreciated that the support housing 202 and the headstock 204 can be similar to and can include many of the same or similar features as the support housing 102 and the headstock 104 described above.

[107] One or more tool modules 228 can be mounted on the front side of the headstock 204. At least one of the tool modules 228 includes a tool feed system 281. As seen, the tool feed system 281 can be similar to the tool feed system 181 except that the tool feed system 281 can have a feed mechanism comprising a tripper sprocket 284 integral to the shaft portion 203 of a tripper shaft 242. The tripper sprocket 284 can comprise a plurality of longitudinal grooves forming a plurality of teeth 215 extending along the shaft portion 203 that define a star-like cross-sectional shape of the shaft portion 203. The tripper shaft 242 is arranged such that every time a tripper pin 213 of a tripper assembly 205 strikes the shaft portion 203 the tripper shaft 242 rotates one tooth 215.

[108] A recess 217 on the support housing 202 (shown in Fig. 11) can be arranged to accommodate at least a portion of the teeth 215 of the tripper shaft 242. The contact point between the tripper pin 213 and the tripper sprocket 284 or the shaft portion 203 can be maintained in the recess 217 even as the tripper shaft 242 is moved up and down with radial adjustments of the tool module 228. In contrast to conventional pipe lathes, the position of the contact point between the tripper pin 213 and the tripper shaft 242 can be within the envelope of the pipe lathe 200 or radially inside of the outer diameter 204A of the headstock 204, eliminating or limiting a dangerous pinch point.

[109] Further, the location of the collision point between the tripper sprocket 284 and the tripper pin 213 can be repositioned relative to the tool module 228 rather than being fixed relative to the tool module as in the prior art, facilitating adjustment of the collision point to better protect an operator from a pinch point associated with the collision point. It will be appreciated that the shaft portion 203 of the tripper shaft 242 can include any configuration suitable to rotate the tripper shaft 242 at least a fraction of a turn when the shaft portion 203 strikes the tripper pin 213.

[110] In operation, upon each complete revolution of the tool module 228, the tripper pin 213 engages a tooth 215 on the shaft portion 203 of the tripper shaft 242 within the recess 217 to rotate tripper shaft 242 a fraction of a turn. The tripper pin 213 can strike the tripper shaft 242 inside of the recess 217 so the injury risk from the pinch point associated with the interaction between the tripper pin 213 and the tripper shaft 242 is eliminated or limited. The risk or threat of an operator getting a hand or finger injured at the contact point of the tripper pin 213 and the tripper shaft 242 is removed.

[111] The tripper shaft 242 can be attached to a second connecting gear 240 so rotation of the tripper shaft 242 causes rotation of the second connecting gear 240. The second connecting gear 240 meshes with a first connecting gear 238 so rotation of the second connecting gear 240 causes rotation of the first connecting gear 238. The first connecting gear 238 can be attached to a feed screw 236 so rotation of the first connecting gear 238 causes rotation of the feed screw 236.

[112] The feed screw 236 can be threadedly attached to a feed nut 296 so rotation of the feed screw 236 causes the feed nut 296 to advance up and down along the feed screw 236. The interaction between the feed screw 236 and the feed nut 296 can be below a base member 272. A potentially dangerous pinch point between the feed screw 236 and the feed nut 296 is eliminated or limited. The feed nut 296 is operatively coupled to a tool holder 234 so rotation of the feed screw 236 results in radial movement (e.g., up and down translation) of the tool holder 234. The tool feed system 281 can be substantially free of potentially dangerous pinch points.

[113] A third exemplary embodiment of a portable lathe machine comprising a pipe lathe 300 is shown in Fig. 12. The pipe lathe 300 can include a support housing 302 and a headstock 304 rotatably mounted to the support housing 302. It will be appreciated that the support housing 302 and the headstock 304 can be similar to and can include many of the same or similar features as the support housing 102 and the headstock 104 described above.

[114] One or more tool modules 328 can be mounted on a front side of the headstock 304. At least one of the tool modules 328 can be similar to the tool module 128 except that the tool module 328 includes a tool feed system 381 having a pawl and ratchet wheel configured to interact one with another. More particularly, the tool module 328 can include a housing 325 mounted within a bore in a headstock 304 of the pipe lathe 300. A feed mechanism comprising a pawl arm 319 can be slidably positioned within a bore extending through the housing 325 of the pipe lathe 300. The pawl arm 319 can be movable between a resting position and an extended position, wherein the pawl arm 319 is translated toward a tool block 332.

[115] The pawl arm 319 can include a tripper pin return spring or resilient member that biases the pawl arm 319 toward the resting position. A pawl 321 including a plurality of teeth can be pivotally attached to the pawl arm 319. A ratchet wheel 323 including a plurality of teeth can be attached to a feed screw 336. A cam mechanism can be arranged such that linear movement of the pawl arm 319 causes pivotal movement of the pawl 321 between a resting position and a driving position, wherein the pawl arm 319 pivots toward the ratchet wheel 323 and engages the ratchet wheel 323 to rotate the ratchet wheel 323 a fraction of a turn.

[116] The pawl 321 can include a pawl return spring or resilient member that biases the pawl toward the resting position. A tripper assembly 305 can be mounted in a bore in the support housing 302. The tripper assembly 305 can include a tripper pin 313 including an angled end portion.

[117] In operation, upon each complete revolution of the tool module 328, the angled end portion of the tripper pin 313 strikes an angled end portion of the pawl arm 319 to move the pawl arm 319 from the resting position to the extended position. The collision or contact point between the tripper pin 313 and the pawl arm 319 can be located internal to the pipe lathe 300, which enhances safety by limiting or eliminating pinch points between the tripper pin 313 and the pawl arm 319. Movement of the pawl arm 319 to the extended position causes the pawl 321 to pivot from the resting position of the pawl 321 to the driving position.

[118] In the driving position, the teeth of the pawl 321 mesh with the teeth on the ratchet wheel 323 to cause rotation of the ratchet wheel 323. The feed screw 336 can be attached to the ratchet wheel 323 so rotation of the ratchet wheel 323 causes rotation of the feed screw 336.

[119] The feed screw 336 can be threadedly attached to the feed nut 396 so rotation of the feed screw 336 causes the feed nut 396 to advance up and down along the feed screw 336. The interaction between the feed screw 336 and the feed nut 396 can be positioned under the tool module 328, enhancing safety because a potentially dangerous pinch point between the feed screw 336 and the feed nut 396 is eliminated or limited. An operator is less likely to injure a hand or fingers.

[120] The feed nut 396 can be operatively coupled to a tool holder 334 so rotation of the feed screw 336 results in radial movement of a tool bit carried by the tool holder 334. The movement of the tool holder 334 moves the tool bit (not shown) radially deeper into the work piece about which the tool bit is orbiting. The tripper pin 313 can be provided with a fixed impact or contact point between the pawl arm 319 and the tripper pin 313 such that upon each revolution of the tool module 328, the tripper pin 313 engages the angled end portion of the pawl arm 319 to move the pawl arm 319 to the extended position, causing movement of the pawl 321 from the resting position to the driving position to rotate the feed screw 336 a fraction of a turn.

[121] Once the tripper pin 313 disengages from the pawl arm 319, the tripper pin return spring can bias the pawl arm 319 back to the resting position of the pawl arm 319. Movement of the pawl arm 319 to the resting position can also allow the pawl return spring to then bias the pawl 321 back to the resting position of the pawl 321.

[122] The teeth on the ratchet wheel 323 can extend longitudinally along a portion of the feed screw 336. The ratchet wheel 323 may include a plurality of rows of teeth or any other suitable configuration of teeth. The teeth of the pawl 321 can mesh with the teeth of the ratchet wheel 323 at different positions depending on how or where the block member 332 is mounted on the headstock 304. The position of the ratchet wheel 323 can be adjusted radially with the block member 332 relative to a fixed position of the tripper pin 313. Further, the interaction between the pawl 321 and the ratchet wheel 323 can be positioned under the tool module 328, enhancing safety by limiting or eliminating pinch points that might injure an operator's hand and/or fingers.

[123] A fourth exemplary embodiment of a portable lathe machine comprising a pipe lathe 400 is shown in Figs. 13-19. The pipe lathe 400 can include a support housing 402, a headstock 404, one or more bearing assemblies that rotatably mount the headstock 404 to the support housing 402. Both the support housing 402 and the headstock 404 can be segmented and arranged to be coupled together to form a complete assembly around a work piece to be machined.

[124] For proper centering, a plurality of spacers 420 can be positioned about the interior wall surface of the support housing 402. One or more jack screws 420A can extend radially through the headstock 404 and support housing 402. The jack screws 420A can help stabilize the work piece and react torque from the pipe lathe 400 to the work piece. It will be appreciated that the support housing 402 and the headstock 404 can be similar to and can include many of the same or similar features as the support housing 102 and the headstock 104 described above.

[125] A drive module 435 and a drive gear housing or gear box 447 can be operatively connected to the headstock 404 to rotate the headstock 404. The drive module 435 and the gear box 447 can have many of the same or similar features as the drive module 135 and the gear box 147 except that the gear box 447 can be mounted on the outer radial surface of the support housing 402. As seen in Fig. 13, the gear box 447 can have a generally low-profile shape such as, but not limited to, a generally tapered or wedge-like shape that tapers toward the headstock 404. This has the effect of reducing the overall profile or envelope of the gear box 447, which reduces a pinch point described below.

[126] One or more tool modules 428 can be mounted on the front side of the headstock 404. Referring to Figs. 14 and 15, at least one of the tool modules 428 can include a tool feed system

481. It will be appreciated that the tool feed system 481 can be similar to the tool feed system 181. A feed mechanism comprising a tripper sprocket 484 (shown in Fig. 15) can include teeth 415 cooperating with a fixed tripper pin to cause advancement of a tool holder 434 (shown in Fig. 14) of the tool module 428 towards or away from the surface of the work piece when the headstock 404 is rotated relative to the support housing 402.

[127] A bore in the tripper sprocket 484 can be arranged to substantially match the shape of at least a portion of a shaft portion 403 of a tripper shaft 442 such that the bore of the tripper sprocket 484 can mate with the shaft portion 403 and rotate the tripper shaft 442 when the tripper sprocket 484 rotates. The tripper sprocket 484 can slide on the shaft portion 403 such that the position of the tripper sprocket 484 along the shaft portion 403 can be adjustable.

[128] The tripper shaft 442 can be attached to a block member 432 and interact with a second connecting gear 440 so rotation of the tripper shaft 442 causes rotation of the second connecting gear 440. The second connecting gear 440 meshes with a first connecting gear 438 (shown in Fig. 14) so rotation of the second connecting gear 440 causes rotation of the first connecting gear 438. The first connecting gear 438 can be attached to a feed screw 436 so rotation of the first connecting gear 438 causes rotation of the feed screw 436.

[129] The feed screw 436 can be threadedly attached to a feed nut (not shown in Fig. 14) so rotation of the feed screw 436 causes the feed nut to advance up and down along the feed screw 436. The interaction between the feed screw 436 and the feed nut can be below a base member, eliminating or limiting a potentially dangerous pinch point between the feed screw 436 and the feed nut. The feed nut can be operatively coupled to a tool holder 434 so rotation of the feed screw 436 results in radial movement (e.g., up and down translation) of the tool holder 434.

[130] Referring to Fig. 15, a sprocket support bracket 483 can be in a back cavity 498 of the block member 432. The sprocket support bracket 483 can include a generally planar front side and a generally planar back side disposed opposite the front side of the sprocket support bracket 483. The front side of the sprocket support bracket 483 can face the back side a block member 432. The sprocket support bracket 483 can include a slot that traverses the shaft portion 403 of the tripper shaft 442.

[131] The slot can be arranged to at least partially receive the tripper sprocket 484 such that the sprocket support bracket 483 can support and/or carry the tripper sprocket 484. It will be appreciated that the sprocket support bracket 483 can exhibit any suitable configuration.

[132] The sprocket support bracket 483 and the block member 432 can include a plurality of apertures 487 for receiving a plurality of fasteners 489 to fasten the sprocket support bracket

483 to the block member 432. The apertures 487 can be patterned such that the radial position of the sprocket support bracket 483 including the tripper sprocket can be adjusted by inserting fasteners 489 in different ones of the apertures 487. This allows the sprocket support bracket 483 to selectively position the tripper sprocket 484 at various intervals along the axis of the shaft portion 403 depending on the mounted position of the tool module 428 on the headstock 404.

[133] As the tool module 428 is repositioned for different work piece sizes, the sprocket support bracket 483 and the tripper sprocket 484 can be repositioned along the shaft portion 403 such that the tripper sprocket 484 can remain closely adjacent to the outer diameter 404A (shown in Fig. 13) of the headstock 404. Further, the location of a collision point between the tripper sprocket and a tripper pin described below can be repositioned relative to the tool module 428 rather than being fixed relative to the tool module as in the prior art, facilitating adjustment of the collision point to better protect an operator from a pinch point associated with the collision point. It will be appreciated that the sprocket support bracket 483 and/or the block member 432 can include any suitable number and/or pattern of apertures 487.

[134] As seen in Fig. 13, the tool feed system 481 can include one or more tripper pin assemblies 405 interacting with the tripper sprocket 484. The one or more tripper pin assemblies 405 can include a pair of tripper pin assemblies mounted to the gear box 447. Alternatively, the one or more tripper pin assemblies 405 can include a single tripper assembly 405 mounted on one side of the gear box 447.

[135] Figs. 16-18 illustrate a tripper assembly 405 removed from the gear box 447 shown in Fig. 13 for ease of reference. The tripper assembly 405 can include a tripper housing 407 having a mounting portion 409 and a tripper pin 413 situated within the tripper housing 407.

[136] A first elongated bore 407A can extend between an inner radial side of the tripper housing 407 and a location within the tripper housing 407. A second elongated bore 407B can extend between a top side of the tripper housing and a bottom side or a location within the tripper housing 407. The second bore 407B can intersect the first bore 407A.

[137] Like the tripper pin 113, the tripper pin 413 can provide a fixed impact or contact point between the tripper sprocket 484 and the tripper pin 413 such that upon each complete revolution of the tool module 428, the tripper pin 413 engages a tooth on the tripper sprocket 484 to rotate the tripper sprocket 484 a fraction of a turn, causing rotation of the tripper shaft 442.

[138] As best seen in Figs. 16 and 17, the mounting portion 409 of the tripper assembly 405 can include a plate 409A and a plurality of fasteners 409B extending through through-holes 407C formed in the tripper housing 407. The through-holes 409C can be elongated slots such that the plate 409A and fasteners 409B can move relative to the tripper housing 407, providing at least some degree of adjustability to the mounting plate relative to the tripper housing 407.

[139] The side surface of the gear box 447 can include a plurality of apertures arranged for receiving the fasteners 409B to fasten the tripper housing 407 between the plate 409A and the side surface of the gear box 447, which fastens the tripper assembly 405 to the gear box 447. The mounting portion 409 can clamp the tripper housing 407 between the plate 409A and the side surface of the gear box 447.

[140] As seen in Figs. 17 and 18, the tripper pin 413 can be movable between an engaged position, wherein a free end portion 413A of the tripper pin 413 extends out of the tripper housing 407, a disengaged position, wherein the free end portion 413A of the tripper pin 413 is substantially received within the first bore 407A of the tripper housing 407.

[141] The tripper pin 413 can have any suitable configuration. The tripper pin 413 can include a body portion 413B including the free end portion 413A and a head portion 413C opposite the free end portion 413A. The head portion 413C can have a diameter that is larger than a diameter of the body portion 413B. The head portion 413C can include a sliding contact surface 413D interacting with a corresponding contact area of an actuator described below. The sliding contact surface 413D can have any suitable configuration. For instance, the sliding contact surface 413D can be angled, curved, planar, combinations thereof, or may exhibit other suitable configurations.

[142] A tripper pin return resilient member or spring 491 can be positioned in a recessed portion 407D of the first bore 407A. The tripper pin return spring 491 can be between a bearing surface formed on the inner radial side of the head portion 413C of the tripper pin 413 and a shoulder formed by the recessed portion 407D. The tripper pin return spring 491 may bias the tripper pin 413 toward the disengaged position.

[143] An actuator 493 can be movably positioned within the second bore 407B of the tripper housing 407. The actuator 493 can include a lever portion 495 and an actuating portion 497. The lever portion 495 can have any suitable configuration. For instance, the lever portion 495 can include a shaft portion 495A attached to the actuating portion 497 and a knob 495B attached to the shaft portion 495A facilitating manipulation of the actuator 493.

[144] The actuating portion 497 can include a first end portion 497A arranged for attachment to the lever portion 495 and a second end portion 497B. The second end portion 497B can form a corresponding sliding contact surface 497C interacting with the sliding contract surface 413D of the tripper pin 413. More particularly, the corresponding sliding contact surface 497C can be arranged such that as the actuator 493 moves toward the tripper pin 413, the sliding contact between the sliding contact surface areas 413D, 497C pushes the tripper pin 413 toward the engaged position of the tripper pin 413.

[145] The second end portion 497B can include a cutout 497D defining a generally flat surface 497E. The flat surface 497E can engage a corresponding generally flat surface 413E on the outer radial side of the head portion 413C of the tripper pin 413 to maintain the tripper pin 413 in the engaged position after the corresponding sliding contact surface 497C has slid past the sliding contact surface 413D on the tripper pin 413. The actuating portion 497 can include a retaining member 479 retaining the actuator 493 in the second bore 407B of the tripper housing 407.

[146] Similar to the tripper pin 413, the actuator 493 can be movable between an engaged position, wherein at least some of the second end portion 497B of the actuating portion 497 extends across the first bore 407A and moves the tripper pin 413 toward its engaged position, and a disengaged position, wherein the second end portion of the actuating portion 497B does not extend across the first bore 407A of the tripper housing 407.

[147] The operation of the actuator 493 will now be described according to an embodiment. Downward movement of the lever portion 495 toward the tripper pin 413 can move the actuator toward the engaged position, which causes the tripper pin 413 to move into the engaged position of the tripper pin 413 such that the free end portion 413D extends out of the first bore 407A of the tripper housing 407.

[148] In the engaged position of the tripper pin 413, the interaction between the flat surface 497E and the corresponding flat surface 413E on the outer radial side of the head portion 413C of the tripper pin after the corresponding sliding contact surface 497C has slid past the sliding contact surface 413D on the tripper pin 413 can help maintain the tripper pin 413 in the engaged position.

[149] Optionally, the tripper assembly 405 can include a locking member 499 positionable in a third bore 407E of the tripper housing 407. The locking member 499 can be arranged to selectively engage a locking space 497F formed on the actuating portion 497 when the actuator is in the engaged position. This can help lock the actuator 493 in the engaged position, which can help lock the tripper pin 413 in the engaged position of the tripper pin 413. The locking member 499 can comprise a locking screw, locking latch, or any other suitable locking member.

[150] Upward movement of lever portion 495 of the actuator 493 away from the tripper pin 413 moves the actuator 493 toward the disengaged position. With the actuator 493 in the disengaged position, the tripper pin return spring 491 can automatically bias the tripper pin 413 into the disengaged position.

[151] As seen in Fig. 19, with the tripper assembly 405 mounted to the side surface of the gear box 447 (shown in Fig. 13) and in the engaged position, the tripper pin 413 can be positioned and configured to actuate the tripper sprocket 484 or another suitable feed mechanism substantially adjacent the envelope or outer diameter 404A of the headstock 404. In operation, upon each complete revolution of the tool module 428, the tripper pin 413 can engage a tooth 415 on the tripper sprocket 484 to rotate the tripper shaft 442 a fraction of a turn.

[152] Because the tripper assembly 405 is mounted on the gear box 447, the tripper pin 413 can strike the tripper sprocket 484 substantially adjacent the outer diameter 404A of the headstock 404. More particularly, the contact point between the tripper pin 413 and the tripper sprocket 484 can be closely adjacent to the outer diameter 404A of the headstock 404, reducing the risk or threat of an operator getting a hand or finger injured between the tripper pin and the tripper sprocket 484.

[153] It will be appreciated that since the contact point of the tripper pin 413 and the tripper sprocket 484 is substantially adjacent the outer diameter 404A of the headstock 404 rather than within the headstock 404, the headstock 404 can be arranged without a recess to accommodate a portion of the tripper sprocket 484 and the tripper pin 413. Because the tripper assembly 405 is mounted close to the support housing 402 rather than on a radially protruding tower as in the prior art, the risk of an operator being injured by the tripper tower and/or a pinch point radially spaced from the outer diameter of the headstock on the tripper tower is substantially reduced, making the pipe lathe 400 more compact and safer to operate. While shown attached to the gear box 447, it will be appreciated that the one or more tripper pin assemblies 405 can be mounted in any suitable location on the pipe lathe 400.

[154] Figs. 20-27 show another embodiment of a portable lathe machine 500. The pipe lathe 500 can be a hand-held machine or arranged to be used while being held by an operator. Referring to Figs. 21 and 22, the lathe machine 500 can include a body 501 comprising a support housing 502 and a headstock or rotating head 504, and one or more bearing assemblies that rotatably mount the rotating head 504 to the support housing 502. A drive system 513 including a drive module 510 and a pair of gear boxes 555, 563 are operatively connected to the rotating head 504 to drive rotation of the rotating head 504.

[155] The support housing 502 and/or the rotating head 504 can be generally annular and can have any suitable shape. The support housing 502 can include a back side 522 and a front side 524 disposed opposite the back side 522 of the support housing 502. It will be appreciated that the support housing 502 can exhibit any suitable configuration. For instance, the support housing 502 can comprise a singular member or the support housing 502 can be segmented. The support housing 502 can be formed of any suitable material. The support housing 502 can include aluminum or other suitable metals.

[156] The rotating head 504 can be mounted for rotation about axis 526 on the support housing 502. The rotating head 504 can include a back side 528, which faces the front side 524 of the support housing 502, and a front side 530 disposed opposite the back side 528 of the rotating head 504. The rotating head 504 can be formed of medium-carbon alloy steel, carbon steel, stainless steel, tungsten carbide, combinations thereof, or another suitable material. The rotating head 504 can exhibit any suitable configuration.

[157] A mandrel assembly 506 is arranged to mount the lathe machine 500 to a work piece (e.g., a pipe or tube). The mandrel assembly 506 can include a mandrel shaft 516 arranged to extend through the support housing 502 and the rotating head 504. The mandrel assembly 506 is generally fixed against rotation within the support housing 502 but can move axially relative to the support housing 502, enabling the support housing 502 and the rotating head 504 to be advanced along the mandrel shaft 516. A feed handle 514 is operatively connected to the mandrel shaft 516 such that the mandrel shaft 516 can be axially fed or moved relative to the support housing 502 by manipulation or rotation of the feed handle 514. The feed handle 514 can be manually operated.

[158] According to a variation, the mandrel shaft 516 includes two or more segments removably connected to one another. For instance, a distal end portion 516A of the mandrel shaft 516 can be removable and interchangeable with different end assemblies adapted for use in different operations. In the illustrated embodiment, a set of mandrel blades or jaw blocks 520 are positioned on the distal end portion of the mandrel shaft 516. A mandrel actuator is arranged to cause radial movement of the jaw blocks 520. For example, the mandrel actuator can be operable to cause the jaw blocks 520 to move or extend radially outward to engage an inner surface of the workpiece. The mandrel actuator can include a draw rod that is manually operable and arranged to expand the jaw blocks 520, and mandrel ramps to provide self-centering and/or alignment of the lathe machine 500 to the workpiece. It will be appreciated that while the mandrel assembly 506 is shown including jaw blocks, other configurations are possible. For instance, the distal end portion of the mandrel shaft 516 can include a miter assembly or other assemblies.

[159] As seen in Fig. 22, a pair of tool modules 532, 534 can be mounted on the front side 530 of the rotating head 504. At least one of the tool modules 532, 534 is arranged to selectively mount different tool bits for cutting or machining (e.g., beveling, grooving, or other operations) an end surface of the work piece. While two tool modules are shown, it will be appreciated that the lathe machine 500 can include one, three, four, or any other suitable number of tool modules. In other embodiments, the tool modules can be omitted. For example, the front side 530 of the rotating head 504 can define one or more cutting features for cutting or machining the end surface of the work piece.

[160] When the drive module 510 drives rotation of the rotating head 504, rotation of the feed handle 514 (shown in Fig. 21) can advance the support housing 502 and the tool module 532, 534 along the mandrel shaft 516 (shown in Fig. 21) to machine an end surface of the work piece. The lathe machine 500 is described as being mounted on the interior circumference or perimeter of the workpiece, however, in other embodiments, the lathe machine 500 can be arranged to be mounted on the exterior surface of the workpiece.

[161] The lathe machine 500 includes one or more features arranged to enhance safety by eliminating or limiting pinch points associated with the lathe machine 500. For instance, a gear connection between the drive module 510 and the rotating head 504 is positioned within the body 501 or radially inside of the outer diameter of the rotating head 504. In an embodiment, the gear connection between the drive module 510 and the rotating head 504 is radially positioned between an inner annular shoulder of the support housing 502 and an inner surface of an outer annular shoulder of the support housing 502 described below. As such, potential pinch points between the gear connection of the drive module 510 and the rotating head 504 are positioned radially inside of the pipe lathe 500 where an operator is not in danger of injuring a hand or fingers between the rotating head 504 and the drive module 510. Moreover, the support housing 502 and/or the rotating head 504 provide a physical and/or solid barrier between the operator and potential pinch points associated with the gear connection, reducing the likelihood of injury to the operator. This is in contrast to conventional lathe machines where such gear connections are dangerously and awkwardly exposed outside of the support housing and/or the rotating head. The lathe machine 500 is thus safer and lower profile than in the prior art.

[162] Fig. 23 is a front view the support housing 502 removed from the lathe machine 500 for ease of reference. The support housing 502 defines an outer annular shoulder 538 and an inner annular shoulder 539 radially spaced from the outer annular shoulder 538. A first through-hole 540 is formed in the support housing 502 between the outer and inner annular shoulders 538, 539. The first through-hole 540 is arranged to accommodate a first gear assembly described below. A second through-hole 542 is formed in the support housing 502 and arranged to accommodate a second gear assembly described below. The support housing 502 also defines a central opening 536 arranged to accommodate the mandrel shaft 516. It will be appreciated that in other embodiments the outer annular shoulder 538 can be omitted.

[163] Fig. 24 is a back view of the rotating head 504 removed from the lathe machine 500 for ease of reference. The rotating head 504 defines an opening 544 corresponding to the central opening 536 for accommodating the mandrel shaft 516. The rotating head 504 also defines an outer radial shoulder 546 including an outer radial surface engageable with an inner radial surface of the outer annular shoulder 538 of the support housing 502, providing a support area for the support housing 502.

[164] An inner radial surface of outer radial shoulder 546 includes an internal gear 548 defining a plurality of teeth 550. The internal gear 548 is operatively connected to the drive module 510 such that the interaction between the drive module 510 and the internal gear 548 can drive rotation of the rotating head 504 during operation of the lathe machine 500.

[165] The internal gear 548 can be formed by or integral to the rotating head 504. For instance, the inner radial surface of the outer radial shoulder on the rotating head 504 can define the internal gear 548. This beneficially can provide improved performance and smoother rotation of the rotating head 504 relative to the support housing 502 by reducing the likelihood of improper alignment between the rotating head 504 and the drive module 510. This can also beneficially improve the strength and/or rigidity of the internal gear 548 by eliminating a potential failure point between the rotating head 504 and a separate internal gear.

[166] The internal gear 548 of the rotating head 504 also substantially reduces the overall weight of the lathe machine 500 because the gear connection described below isformed without the need of additional structural components. Moreover, it does so while also reducing the overall profile of the lathe machine 500. This advantageously can lessen operator fatigue, making the lathe machine 500 easier and more comfortable to operate. The internal gear 548 also simplifies the construction of the lathe machine 500, helping to achieve more economical manufacturing cost.

[167] It also advantageously can improve the life of the teeth 550. For instance, the internal gear 548 formed on the rotating head 504 is not a component that operators or other individuals need to remove from the lathe machine 500 for maintenance or inspection. This means they are not repeatedly retightening bolts or other fasteners connecting the internal gear to the rotating head. This is beneficial because the repeated retightening of bolts can result in undesired bolt stretch or slippage in the friction plane between the bolts and the internal gear and/or rotating head, which, in turn, can cause accelerated wear on the teeth. The internal gear 548 thus improves the useful life of the teeth 550 by preventing or eliminating movement between the internal gear 548 and the rotating head 504.

[168] The teeth 550 can be spur teeth, helical teeth, or any other suitable type of teeth. The teeth 550 are described being on the inner radial surface of the outer radial shoulder 546 but can be located on the outer radial surface of the outer annular shoulder or on any other surface suitable to cooperate with the drive module 510. It will be appreciated that in other embodiments, the internal gear 548 may be separate from the rotating head 504. For instance, the internal gear 548 can be defined by a separate ring member attached to the rotating head 504.

[169] Referring to Figs. 25 and 26, the drive module 510 includes a drive motor 552 arranged to be mounted to the back side 522 of the support housing 502. The drive motor 552 can be mounted to the support housing 502 such that the drive motor 552 forms a right-angle point of entry relative to the back side 522 of the support housing. The drive motor 552 can be mounted to the support housing 502 such that the drive motor 552 forms a non-right angle relative to the back side 522 of the support housing 502. The drive motor 552 can be pivotally or non-pivotally mounted on the support housing 502. The drive motor 552 may be air driven, hydraulically driven, or electrically driven.

[170] The drive system 513 is shown including two gear assemblies operable with the drive module 510 but can include any suitable number of gear assemblies. As seen, a first gear assembly 554 and a second gear assembly 556 are arranged to be mounted to the back side 522 of the support housing 502. The first gear assembly 554 and/or the second gear assembly 556 can be removably attached to the back side 522 of the support housing 502.

[171] The first gear assembly 554 is inserted in the first through-hole 540 such that the first gear assembly 554 extends generally axially between the back side 522 of the support housing 502 and the internal gear 548 of the rotating head 504. The first gear assembly 554 can include the first gear box 555, a first protective cover 558, and a first gear member 560 defining a first plurality of teeth 562 arranged to interact or mesh with the teeth 550 of the rotating head 504.

[172] The second gear assembly 556 is inserted in the second through-hole 542 such that the second gear assembly 556 extends generally axially between the back side 522 of the support housing 502 and the internal gear 548 of the rotating head 504. The second gear assembly 556 can include the second gear box 563, a second protective cover 564, and a second plurality of teeth 568 interacting or meshing with the teeth 550 of the rotating head 504. Because the second gear assembly 556 forms a second or different point of contact in addition to the point of contact between the first gear assembly 554 and the internal gear 548, the second gear assembly 556 can help stabilize the rotating head 504 as it rotates relative to the support housing 502 and transmit torque.

[173] The first gear assembly 554 is arranged for connection to the drive motor 552. The drive motor 552 can be removably connected to the first gear assembly 554. The second gear assembly 556 is arranged for connection to the drive motor 552. The drive motor 552 can be removably connected to the second gear assembly 556. With the drive motor 552 connected to the first gear assembly 554, operation of the drive motor 552 drives rotation of the first gear member 560, which rotates the rotating head 504 about the axis 526, which rotates the second gear member 566. With the drive motor 552 connected to the second gear assembly 556, operation of the drive motor 552 drives rotation of the second gear member 566, which rotates the rotating head 504 about the axis 526, which rotates the first gear member 560.

[174] The first gear member 560 and the second gear member 566 can have different diameters so that the first gear member 560 and the second gear member 566 rotate at different speeds. As such, by moving the drive motor 552 between the first and second gear assemblies 554, 556, the output torque and rotational speed of the lathe machine 500 can be varied. The lathe machine 500 can thus be operated at lower speed, higher torque or at higher speed, lower torque. In other embodiments, the first gear member 560 and the second gear member 566 can have a same diameter. According to a variation, the second gear assembly 556 can be arranged for interaction with a second drive motor different than the drive motor 552 such that the pipe lathe 500 is driven by dual drive motors.

[175] The first gear member 560 and the second gear member 566 are located inside the body 501 between the support housing 502 and the rotating head 504. In addition, the first member 560 and the second gear member 566 are located within their respective protective covers and gear boxes. The interaction between the internal gear 548 and the first and second gear members 560, 566 is also located within and/or concealed by the rotating head 504 and the support housing 502 and/or between the outer annular shoulder 538 and the inner annular shoulder 539 of the support housing 502. Safety of the lathe machine 500 is thus enhanced because the body 501, the support housing 502, and/or the rotating head 504 limits or eliminates any pinch point associated with the gear connections. Embodiments of the lathe machine thus reduce the risk of an operator injuring a hand or fingers during operation of the lathe machine.

[176] Moreover, because the first gear member 560 and the second gear member 566 are located radially inside of the outer diameter of the support housing 502, substantially the entire outer diameter of the lathe machine 500 can be relatively free of pinch points or other obstacles that could injure an operator, improving operator safety. Because there are also little or no obstructions associated with the outer diameter of the support housing 502 and/or the rotating head 504, potential pinch points between such obstructions are eliminated or reduced.

[177] Fig. 27 illustrates the first and second gear assemblies 554, 556 according to an embodiment. The first drive assembly 554 includes a first drive shaft 570 positioned within the housing 555 and is coupled to the drive motor 552. The first drive shaft 570 is also attached to the first gear member 560. Operation of the drive motor 552 can drive rotation of the first drive shaft 570, which rotates the first gear member 560, which rotates the rotating head 504.

[178] The first drive shaft 570 and the first gear member 560 can be mounted to the support housing 502 via at least one bearing assembly. According to a variation, a plurality of bearing assemblies 572 can operatively mount the first drive shaft 570 and the first gear member 560 to the support housing 502. Two of the bearing assemblies 572 are shown disposed between the drive motor 552 and the first gear member 560 and another of the bearing assemblies 572 is shown disposed on the opposite side of the first gear member 560.

[179] The bearing assemblies 572 can comprise any suitable type of bearing assembly. In and embodiment, each bearing assembly 572 includes an inner race 578 (i.e., a rotor) defining an opening through which the first drive shaft 570 extends and an outer race 580 (i.e., a stator) that extends about and receives the inner race 578. The outer radial surface of the outer race 580 can be attached to the housing 555 or the protective case 564. A plurality of bearing elements 582 are disposed between the inner and outer races 578, 580. The bearing assemblies

572 are arranged to reduce friction and facilitate smoother and easier rotation of the rotating head 504. The bearing assemblies 572 can be arranged to transfer axial and/or radial loads from the rotating head 504 to the support housing 502.

[180] As seen, the bearing assemblies 572 are protected within the housing 555 and the protective case 558, providing a safer design without substantially increasing machine weight, size, and/or production cost and without a significant decrease in performance.

[181] In an embodiment, the second gear assembly 556 can be similar to the first gear assembly 554. For instance, the second gear assembly 556 can include a second drive shaft 574 attached to the second gear member 566 and one or more bearing assemblies 576 protected within the second housing 563 and the second protective case 564.

[182] Fig. 28 shows a portable lathe machine 600 according to yet another embodiment. As seen, the lathe machine 600 can be similar to the lathe machine 500. The lathe machine 600 can include a body 601. The body can include a support housing 602 and a rotating head 604 defining an internal gear, and one or more bearing assemblies that rotatably mount the rotating head 604 to the support housing 602. A drive system 613 includes a drive module 610 operatively connected to the rotating head 604 to drive rotation of the rotating head 604. Similar to the previously described embodiments, at least one gear connection is formed between the internal gear of the rotating head 604 and the drive module 610. The at least one gear connection is positioned radially inside of an outer diameter of the support housing 602 to protect an operator from a pinch point associated with the at least one gear connection, making the lathe machine 600 safer to operate and reducing the profile of the lathe machine 600.

[183] A mandrel assembly 606 is arranged to mount the lathe machine 600 to a work piece. The mandrel assembly 606 can include a mandrel shaft 616 arranged to extend through the support housing 602 and the rotating head 604. In the illustrated embodiment, a distal end 616A of a mandrel shaft 616 includes a miter assembly 680 for miter cutting on a workpiece. Similar to the previous embodiments, the miter assembly 680 can be removable and interchangeable with different end assemblies adapted for use in different operations.

[184] Fig. 29 shows a portable lathe machine 700 according to yet another embodiment. The lathe machine 700 can be similar to the lathe machine 500. The lathe machine 700 can include a body 701. The body 701 can include a support housing 702 and a rotating head 704 defining an internal gear, and one or more bearing assemblies that rotatably mount the rotating head 704 to the support housing 702. A drive system 713 includes a drive module 710 operatively connected to the rotating head 704 to drive rotation of the rotating head 704. Similar to the previously described embodiments, at least one gear connection is formed between the internal gear on the rotating head 704 and the drive module 710. The at least one gear connection is positioned radially inside of an outer diameter of the support housing 702 to protect an operator from a pinch point associated with the at least one gear connection, making the lathe machine 700 safer to operate and reducing the profile of the lathe machine 700.

[185] As seen, the rotating head 704 can have a non-circular shape. For instance, the rotating head 704 has an elongate configuration that tapers from a first end portion 704A having a rounded configuration toward a second end portion 704B having a flat or square configuration. The elongated configuration of the rotating head 704 can facilitate the machining of larger pipe diameters and/or the attachment of different tooling modules to the lathe machine 700.

[186] It should be appreciated that embodiments of the lathe machine can include any suitable drive module and/or gear connections. For instance, the drive module can include bevel gear sets, straight cut miter gear sets, skew bevel gears, helical gear sets, spiral bevel gear sets, combinations thereof, or any other suitable gear configurations. In other embodiments, the lathe machine can include one, three, four, or any other suitable number of drive assemblies. In addition, the embodiments of the drive systems described can be utilized with any suitable rotating machining or cutting device including, but not limited to, split frame pipe lathes, multi-axis spindles, milling machines, and/or boring machines.

CLAIMS:

1. A portable lathe machine for machining a work piece comprising:

a support housing adapted for mounting on the work piece;

a rotating head rotatably mounted on the support housing about an axis and including an internal gear;

at least one tool module mounted on a front side of the rotating head; and

a drive module arranged to drive rotation of the rotating head about the axis,

wherein the rotating head defines the internal gear and at least one gear connection formed between the internal gear and the drive module, the at least one gear connection radially positioned inside an outer diameter of the support housing to protect an operator from a pinch point associated with the at least one gear connection.

2. The portable lathe machine of claim 1, further comprising a body including the support housing and the rotating head, the at least one gear connection being concealed within the body.

3. The portable lathe machine of claim 1, wherein the support housing defines inner and outer annular shoulders and the at least one gear connection is radially positioned between the inner and outer shoulders of the support housing.

4. The portable lathe machine of claim 3, wherein the rotating head defines an outer radial shoulder having an outer surface engageable with an outer surface of the outer annual shoulder of the support housing.

5. The portable lathe machine of claim 3, wherein the outer annual shoulder of the support housing overlaps the internal gear.

6. The portable lathe machine of claim 1, wherein the support housing defines a through-hole such that the drive module extends axially through the support housing.

7. The portable lathe machine of claim 1, wherein the drive module includes at least one gear member defining teeth arranged to mesh with the internal gear.

8. The portable lathe machine in claim 7, wherein the at least one gear member comprises a helical gear or a spur gear.

9. The portable lathe machine of claim 7, wherein the at least one gear member is located radially inside of the outer diameter of the support housing.

10. The portable lathe machine of claim 9, wherein the at least one gear member comprises first and second gear members arranged to mesh the internal gear.

11. The portable lathe machine of claim 1, wherein the drive module is pivotally mounted to the support housing.

12. The portable lathe machine of claim 1, further comprising a mandrel assembly including a mandrel shaft arranged to extend through the support housing and the rotating head, the mandrel assembly being fixed against rotation relative to the support housing.

13. The portable lathe machine of claim 12, wherein the mandrel assembly is arranged to move axially relative to the support housing.

14. The portable lathe machine of claim 1, wherein the support housing has a segmented configuration.

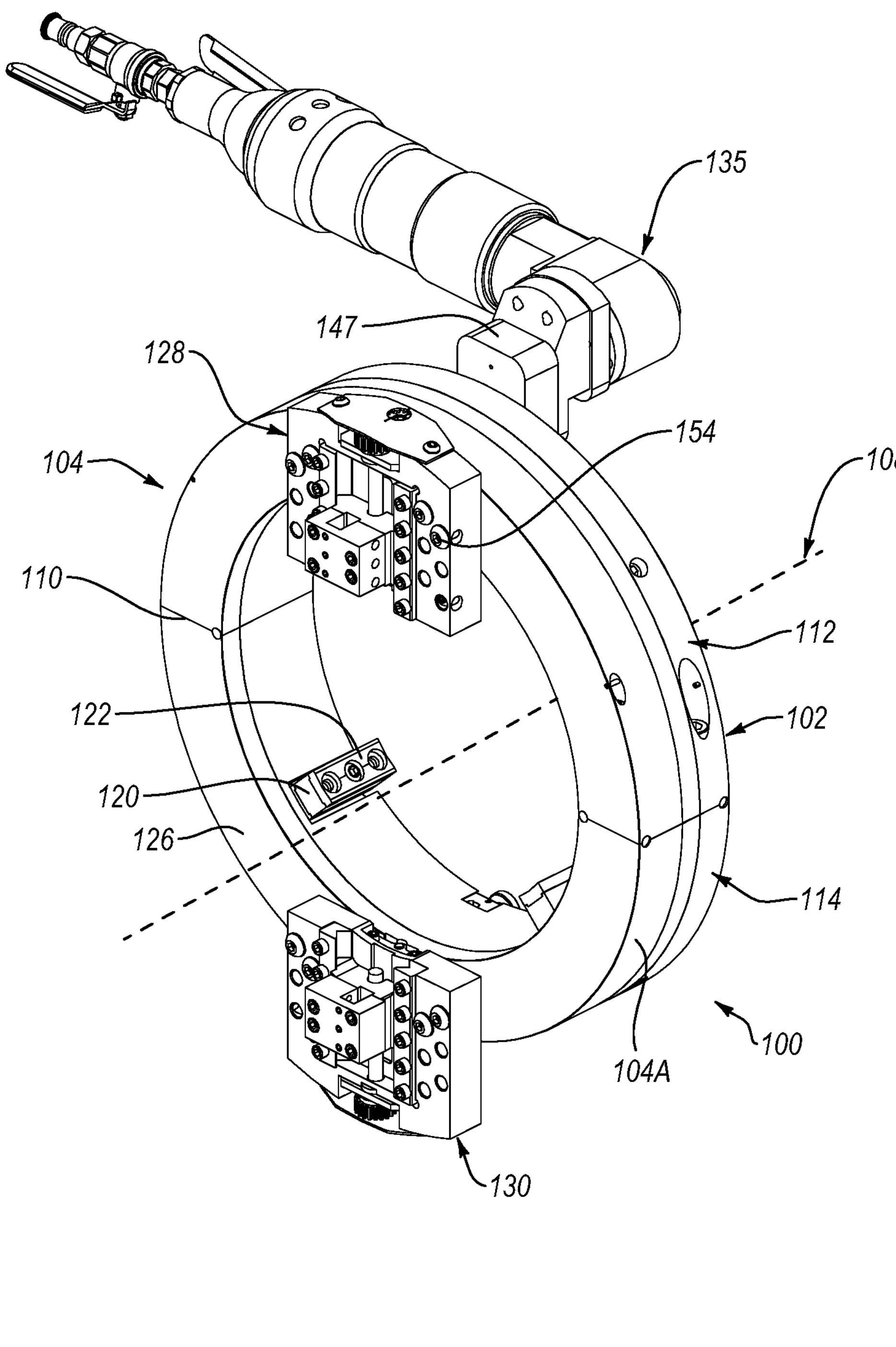

FIG. 1

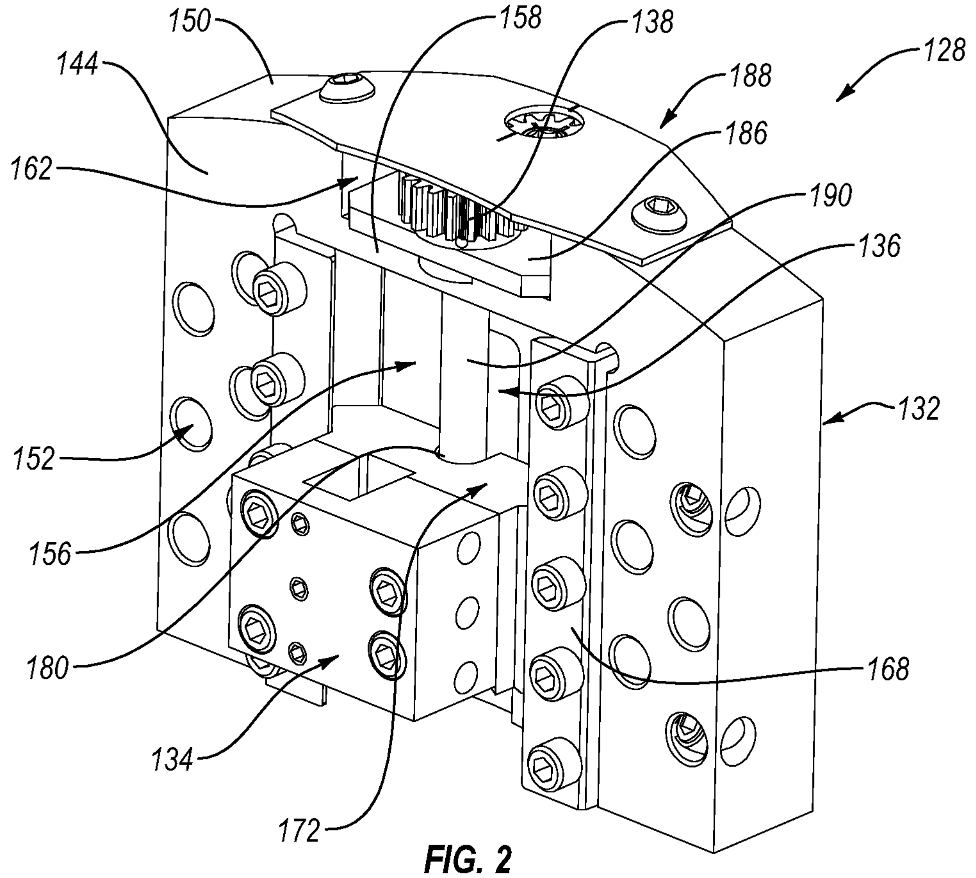
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FIG. 2

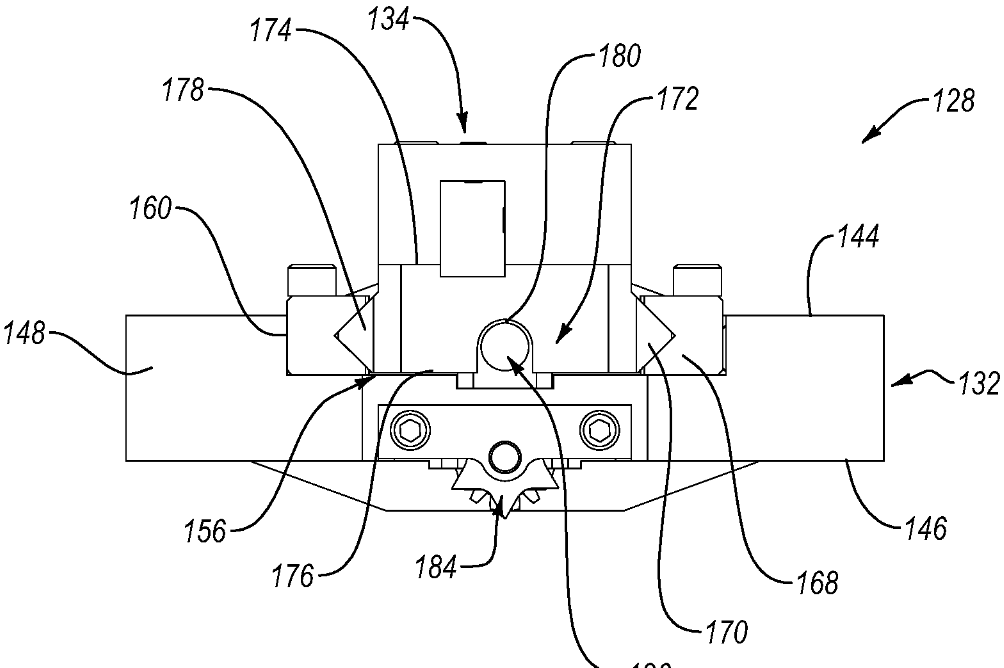
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FIG. 3

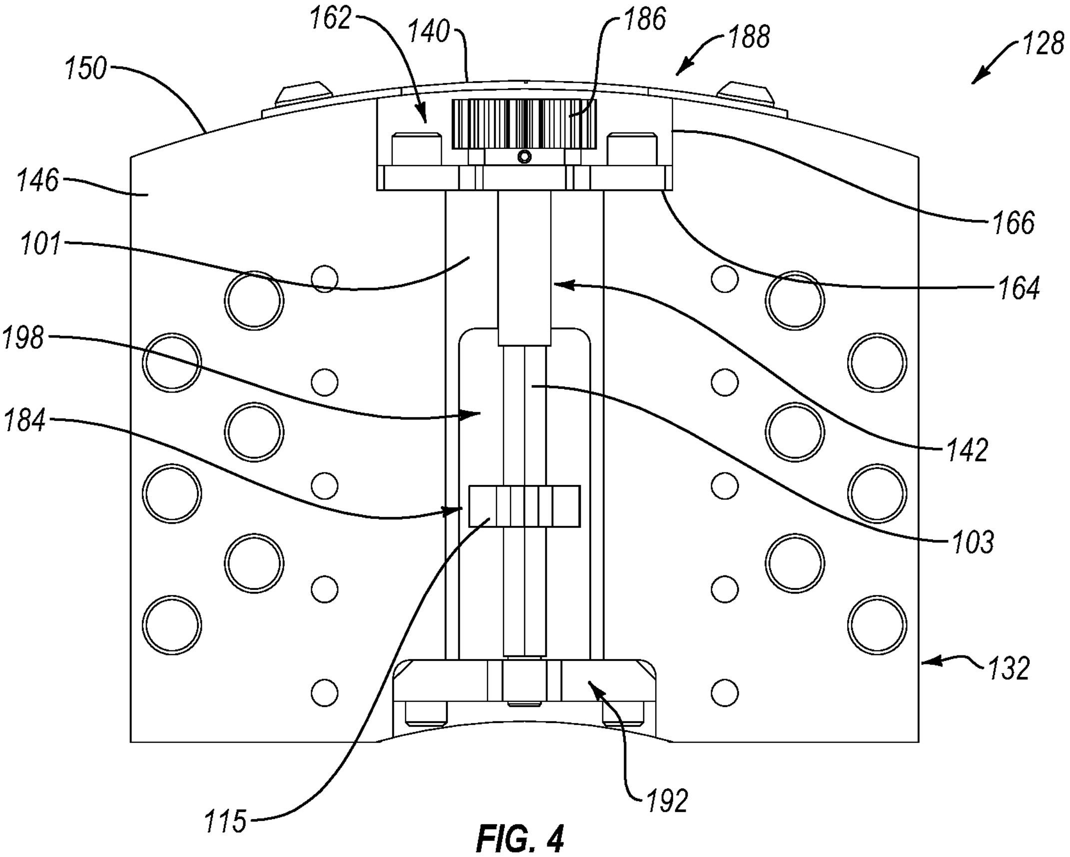
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FIG. 4

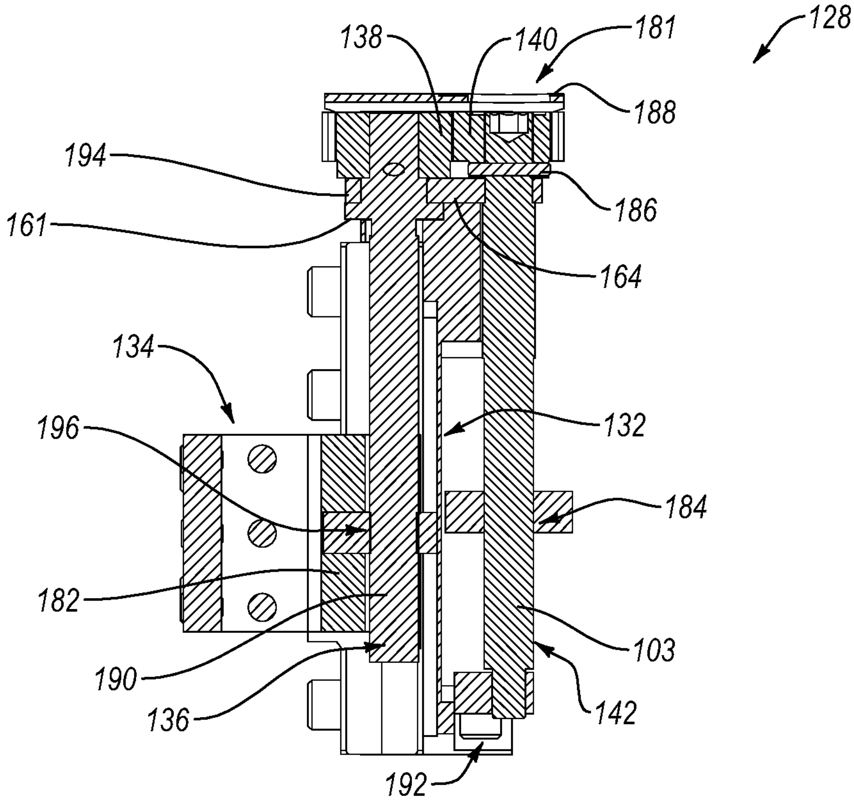
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FIG. 5

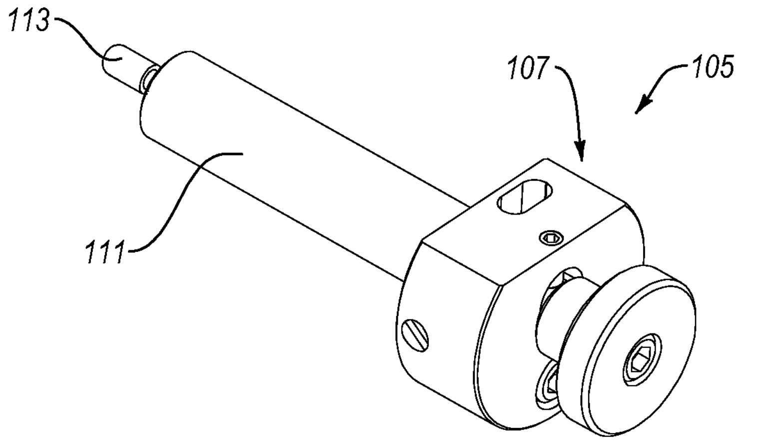
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FIG. 6

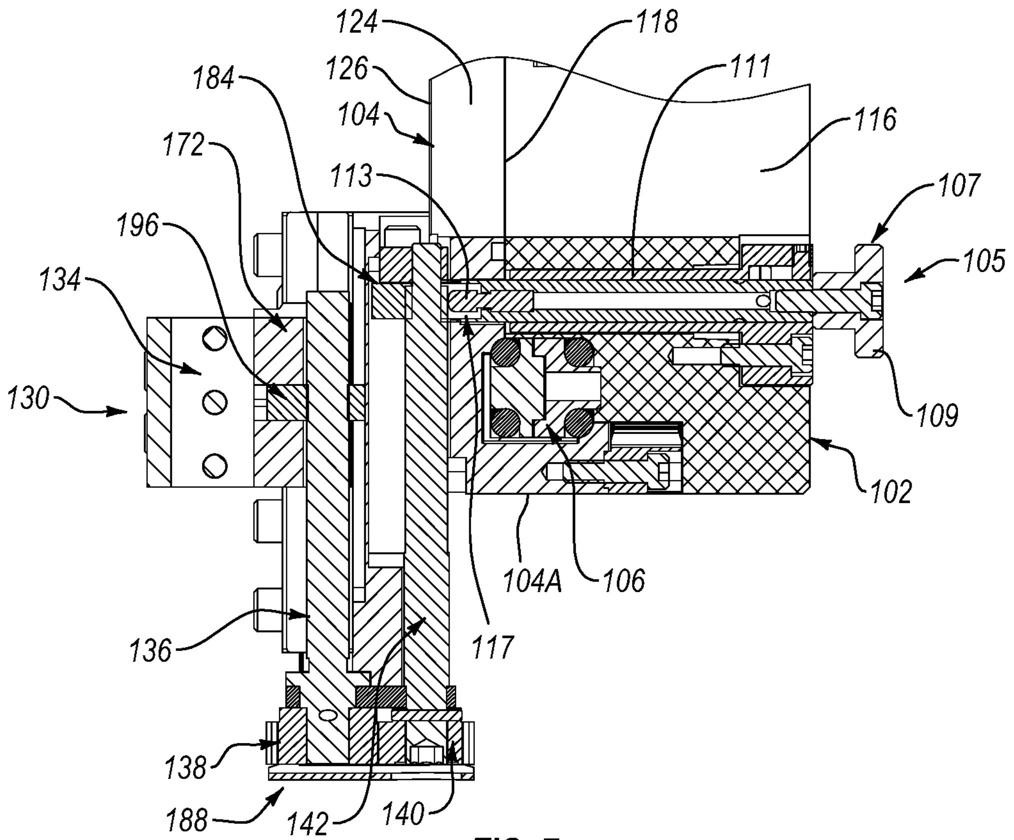
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FIG. 7

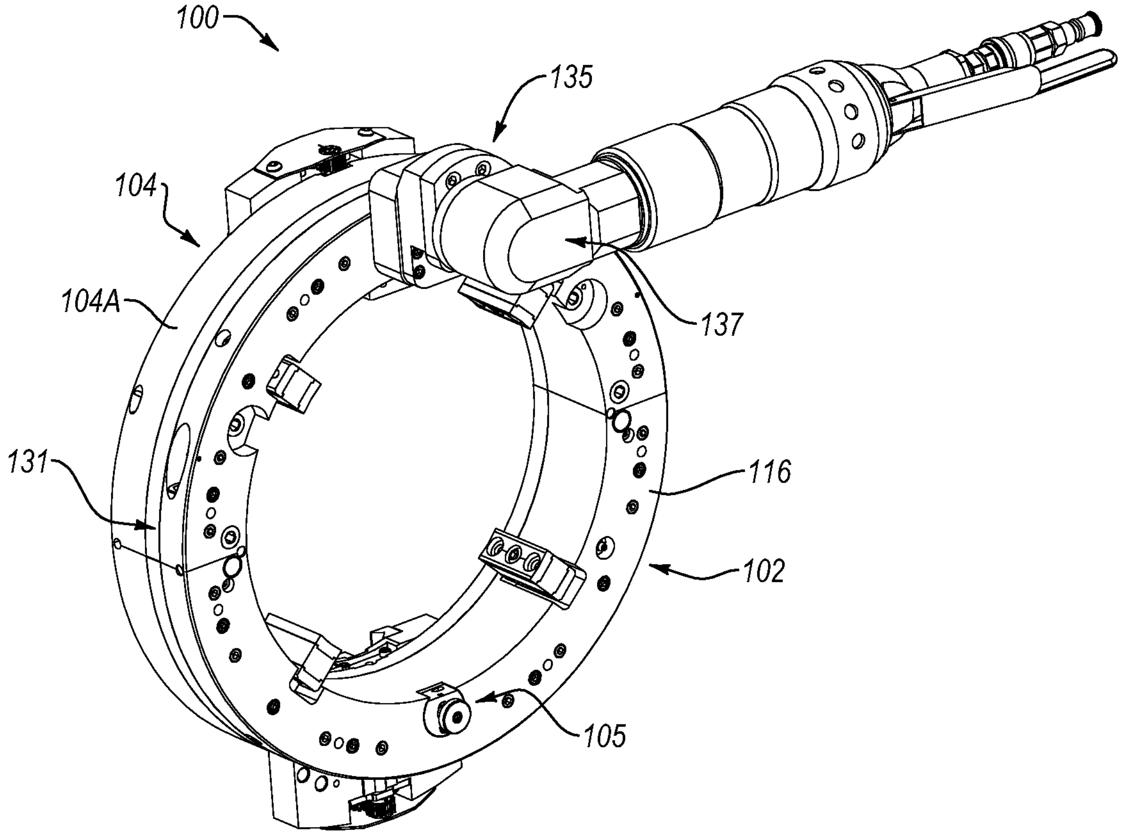
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FIG. 8

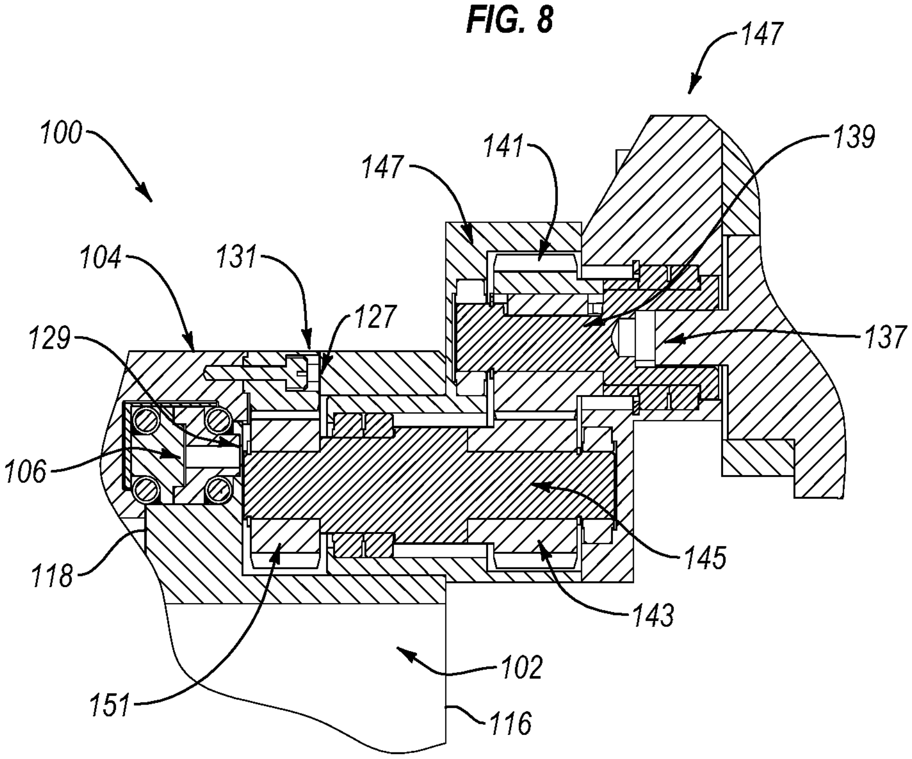
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FIG. 9

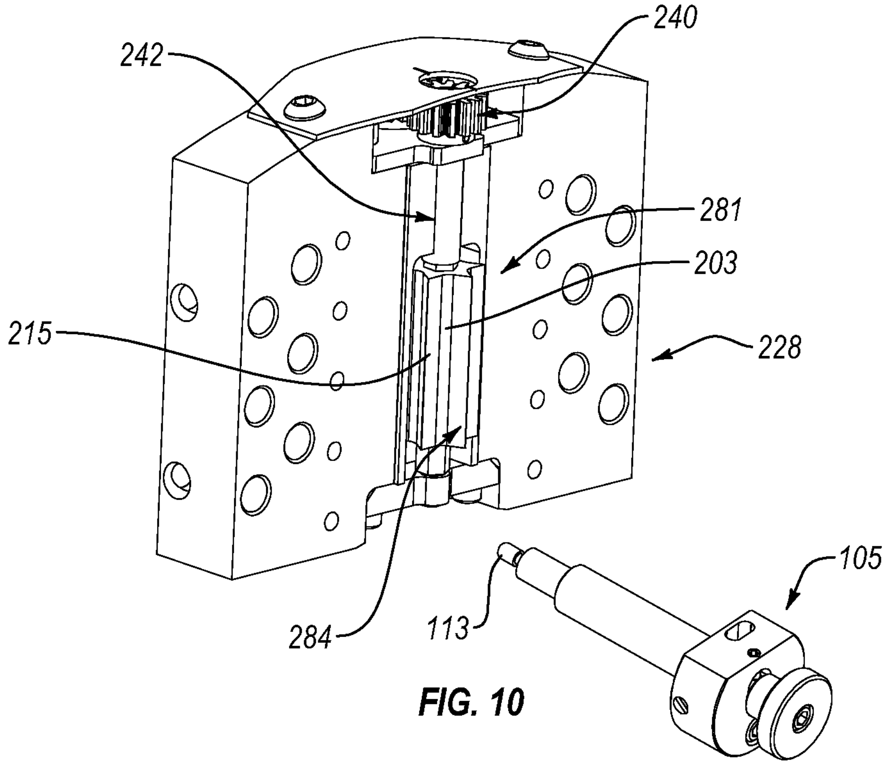
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FIG. 10

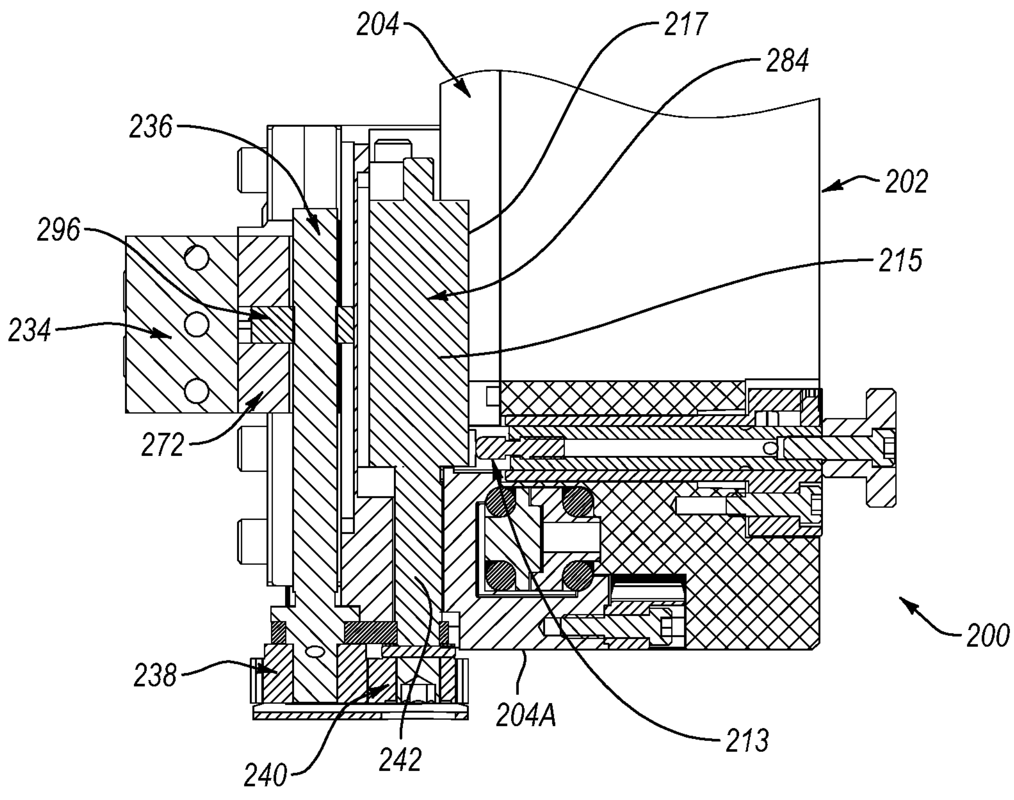
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FIG. 11

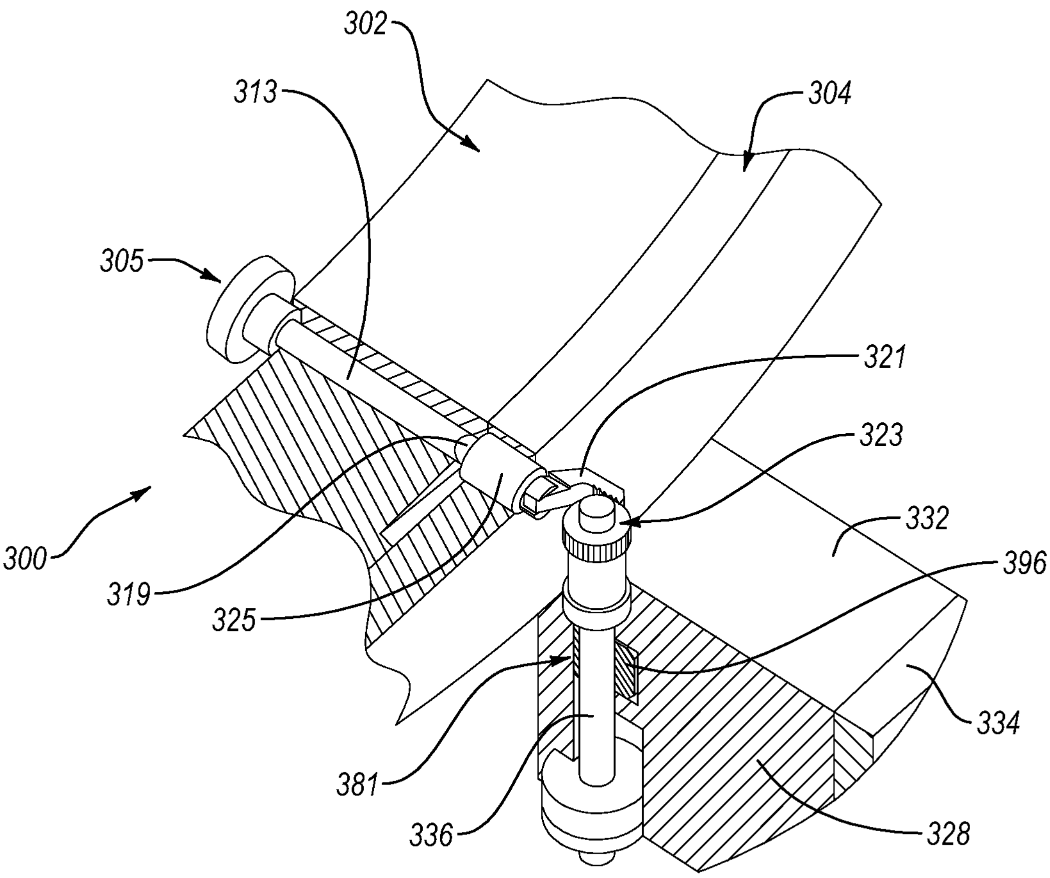

FIG. 12

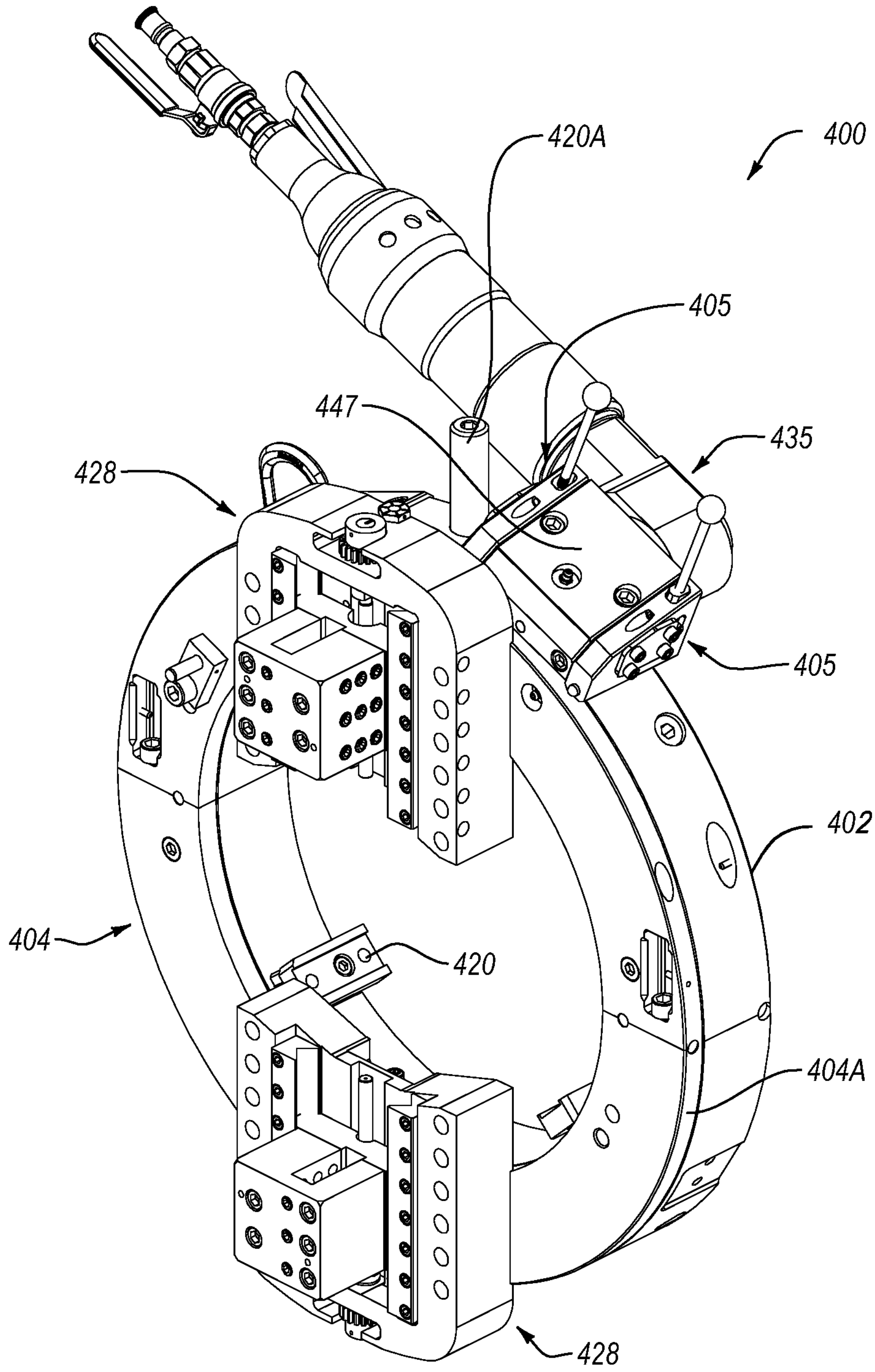

FIG. 13

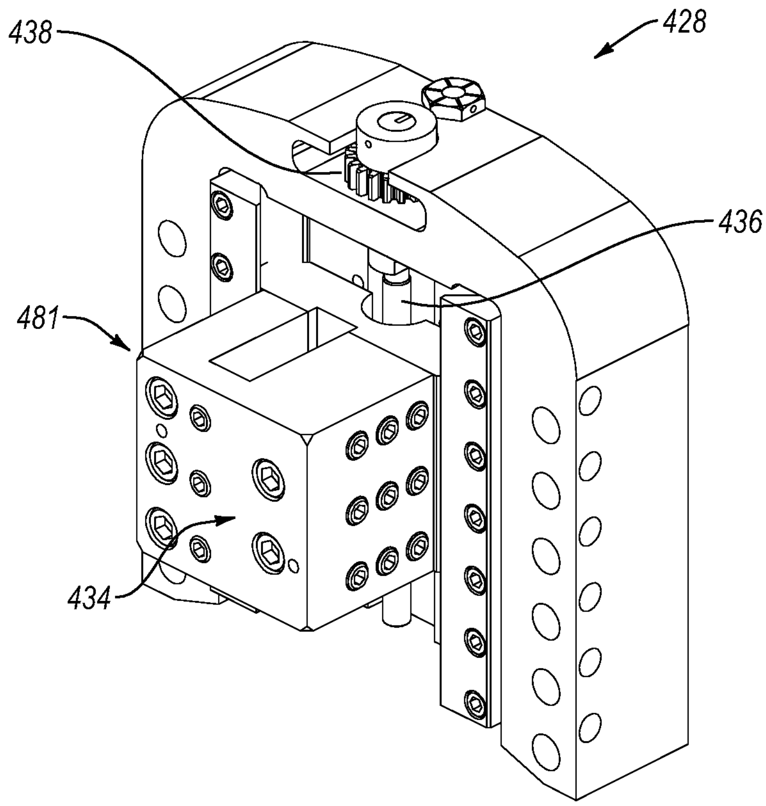

FIG. 14

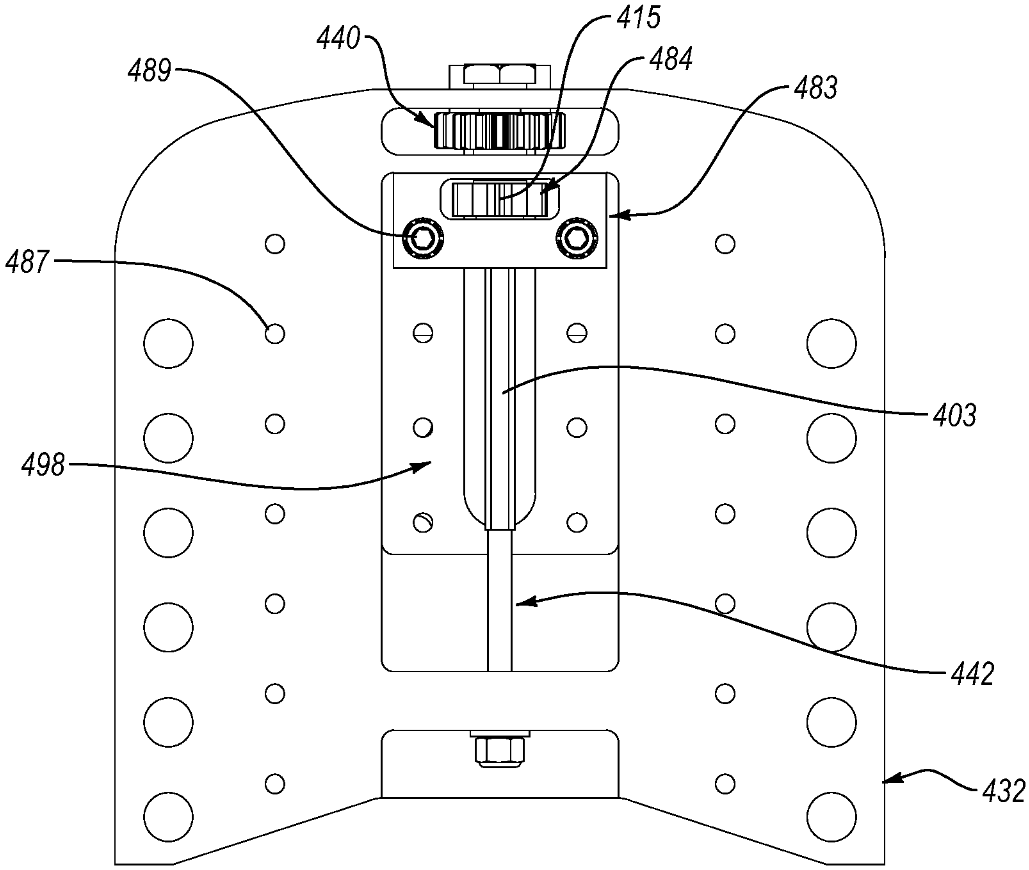

FIG. 15

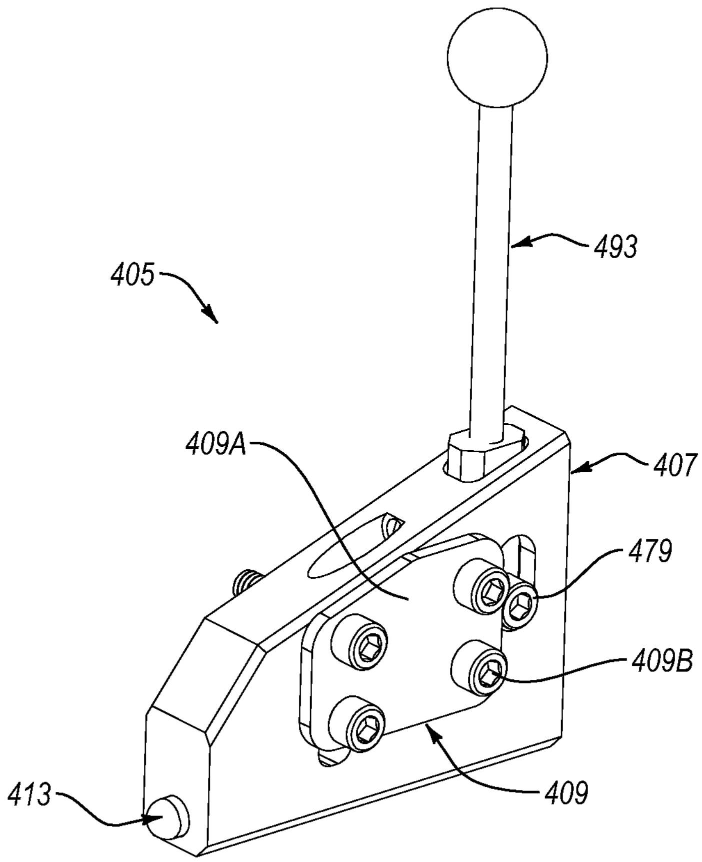

FIG. 16

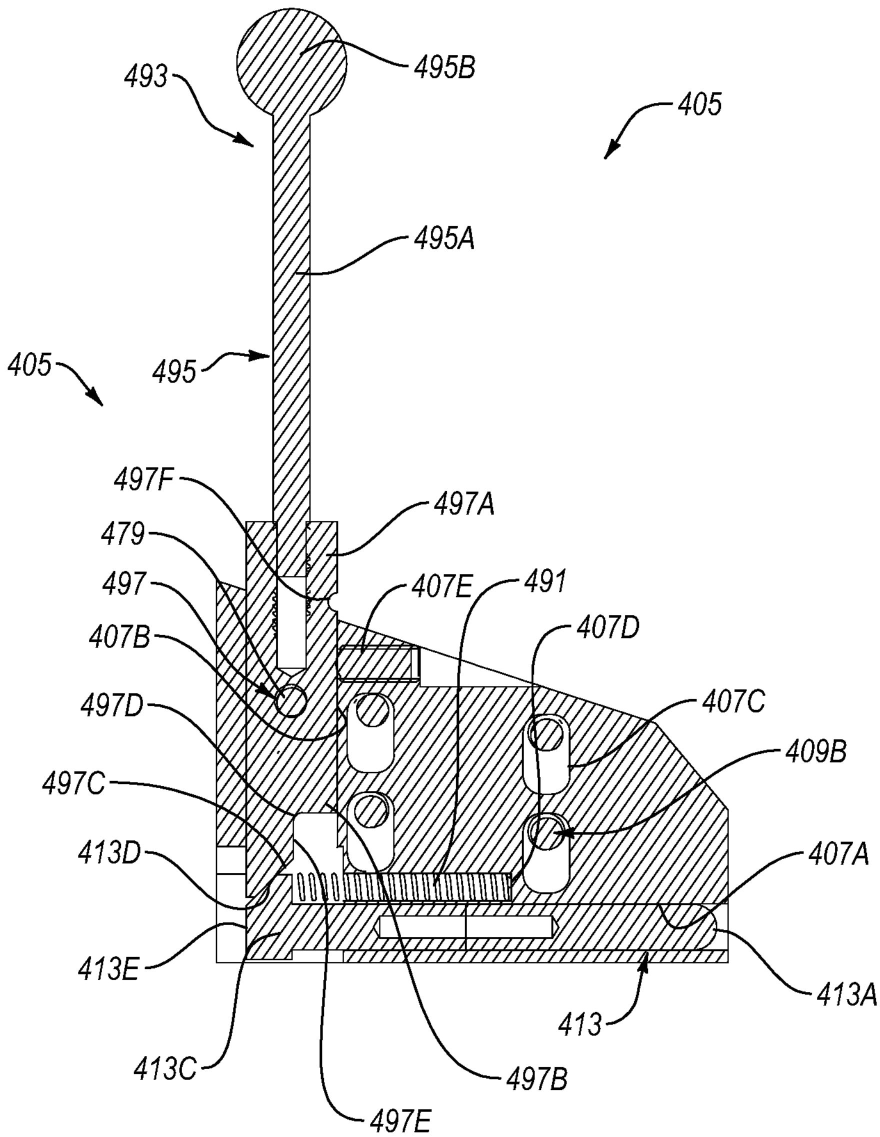
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FIG. 17

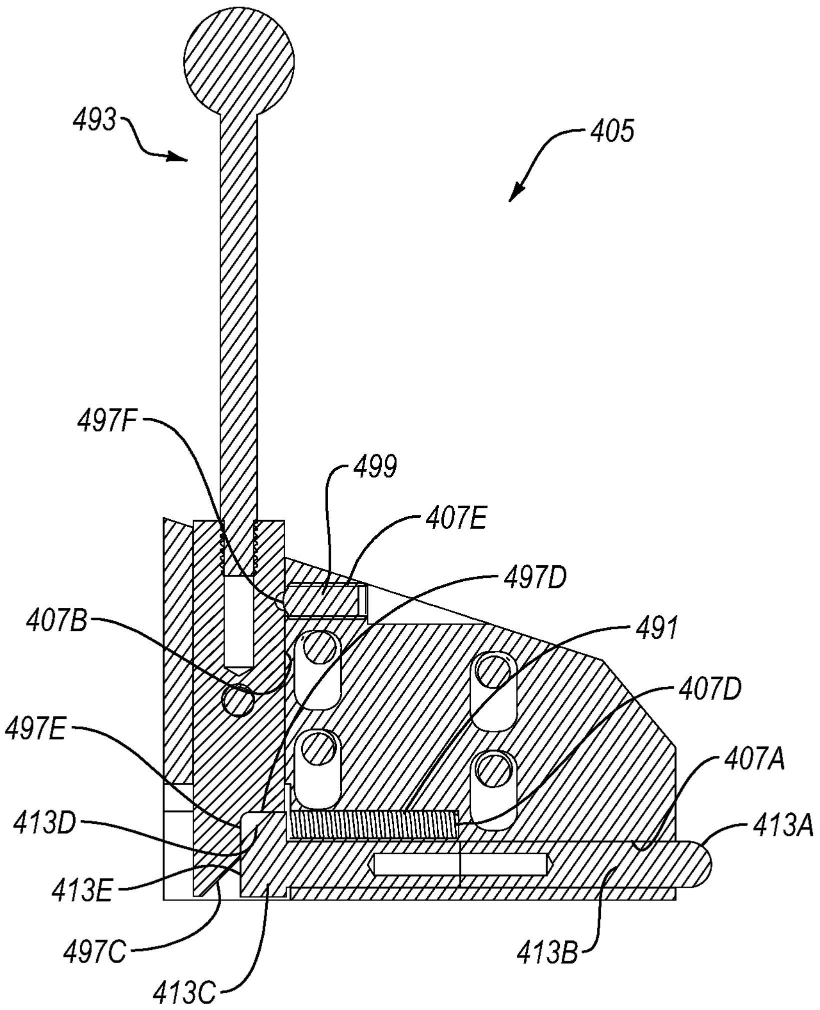
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FIG. 18

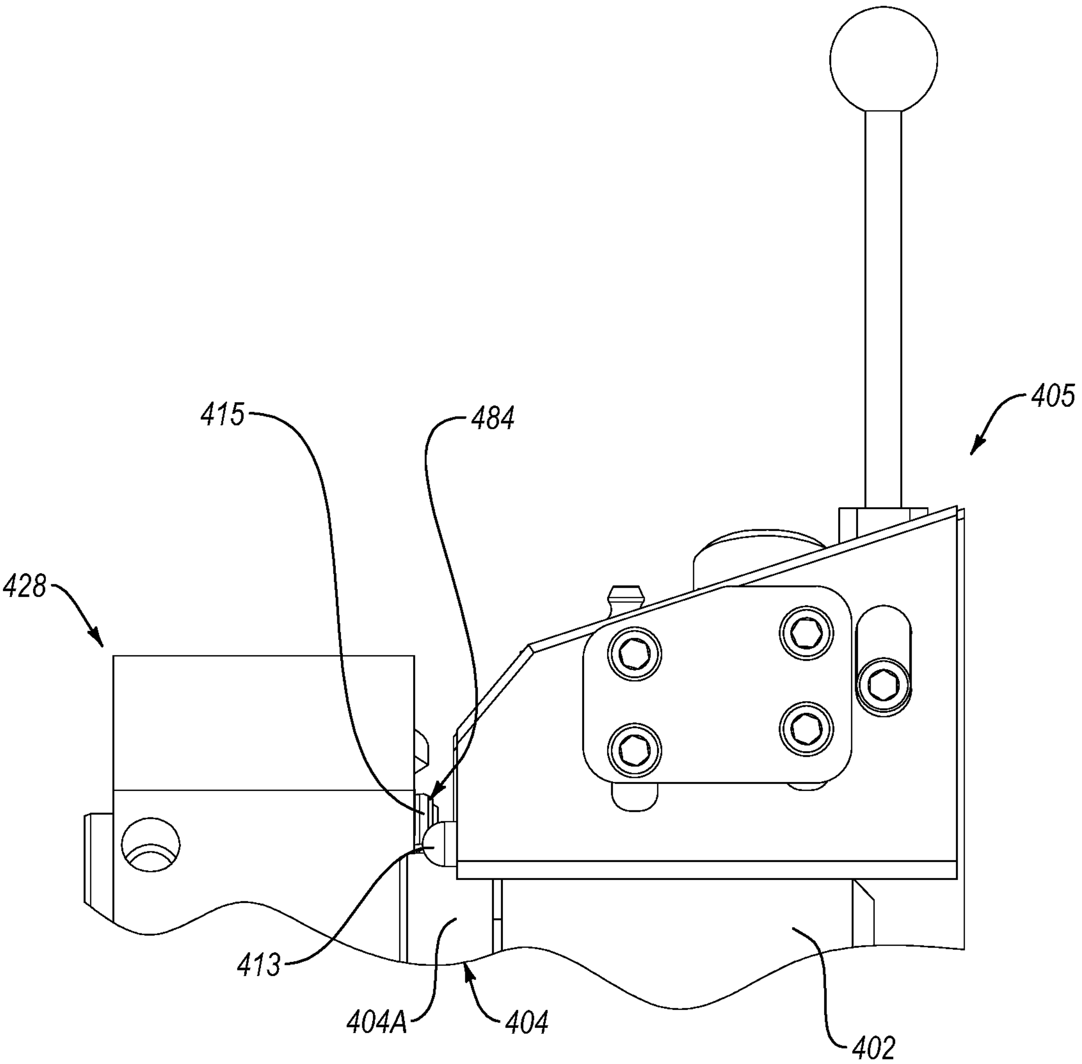


FIG. 19

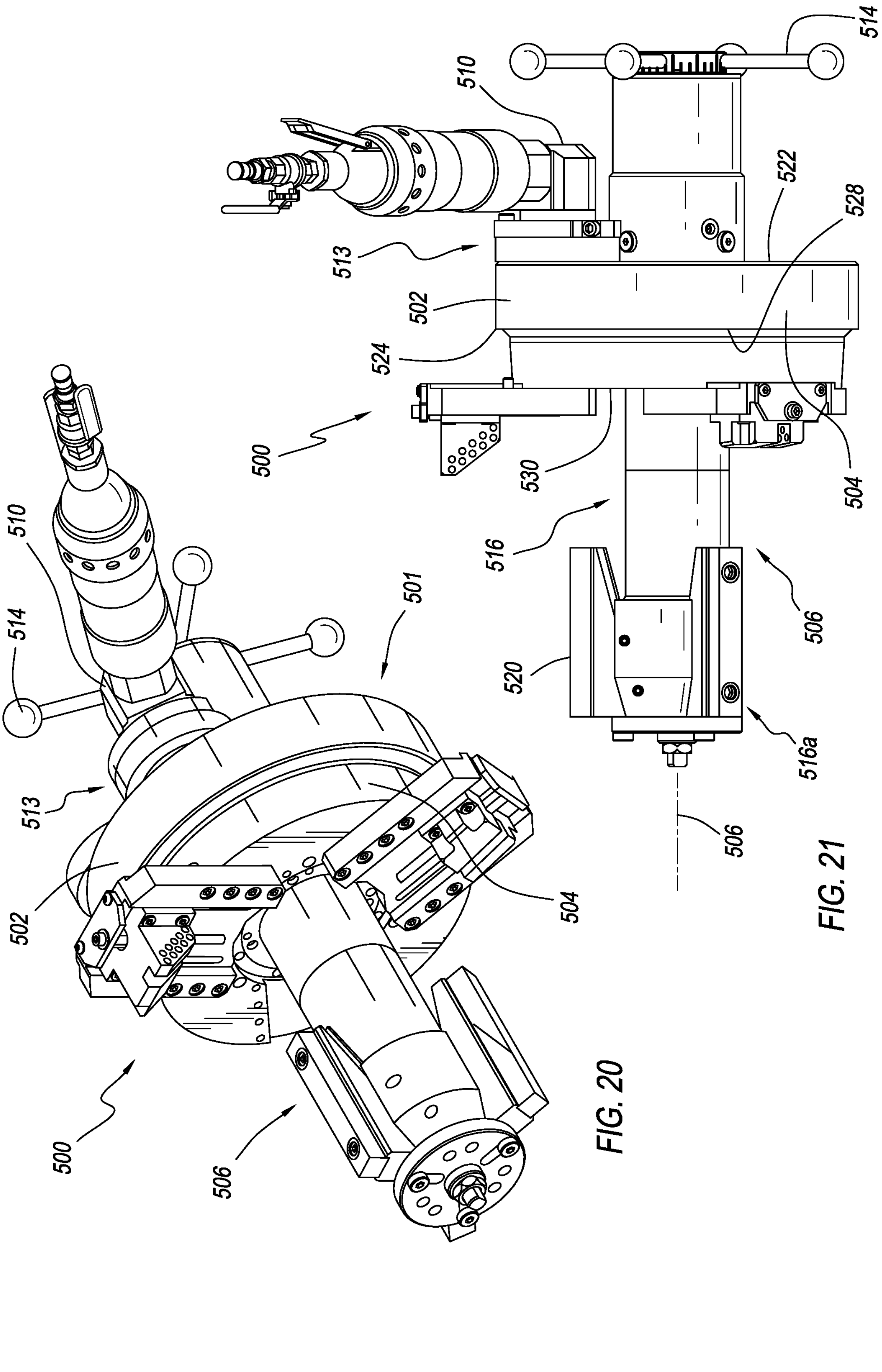

514
510
513
502
524
522
528
500
530
504
516
506
520
516a
506
510
514
501
513
502
504
500
506

FIG. 21

FIG. 20

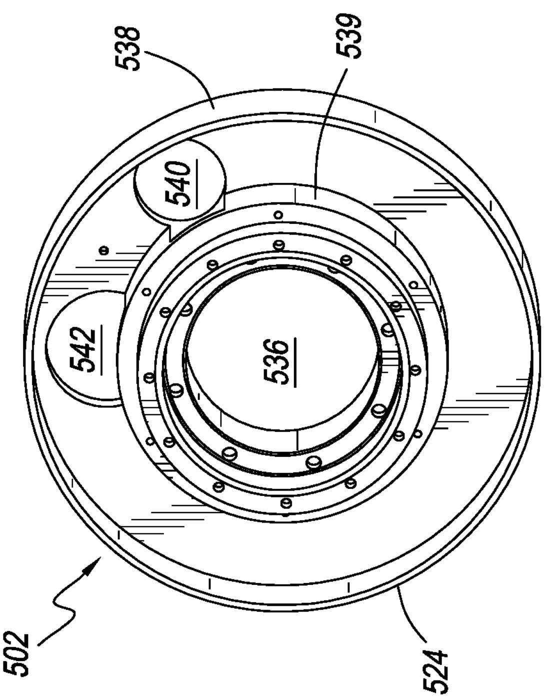


FIG. 23

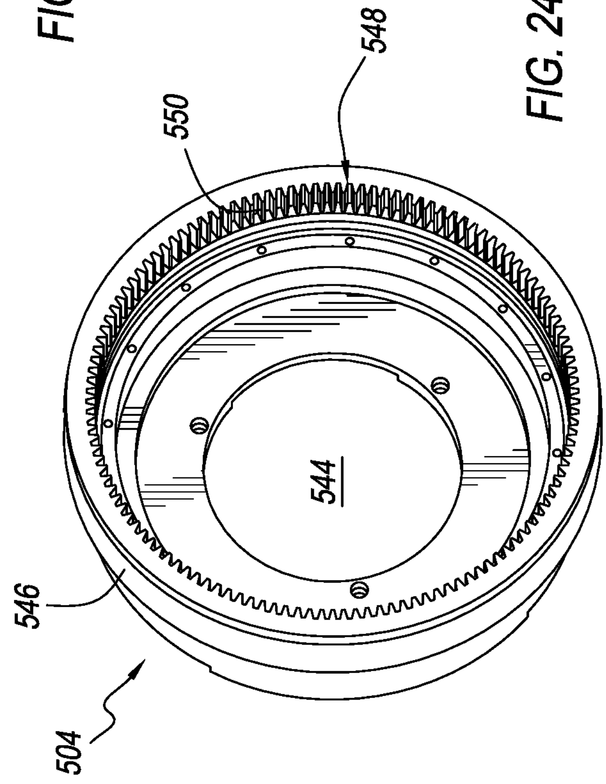


FIG. 24

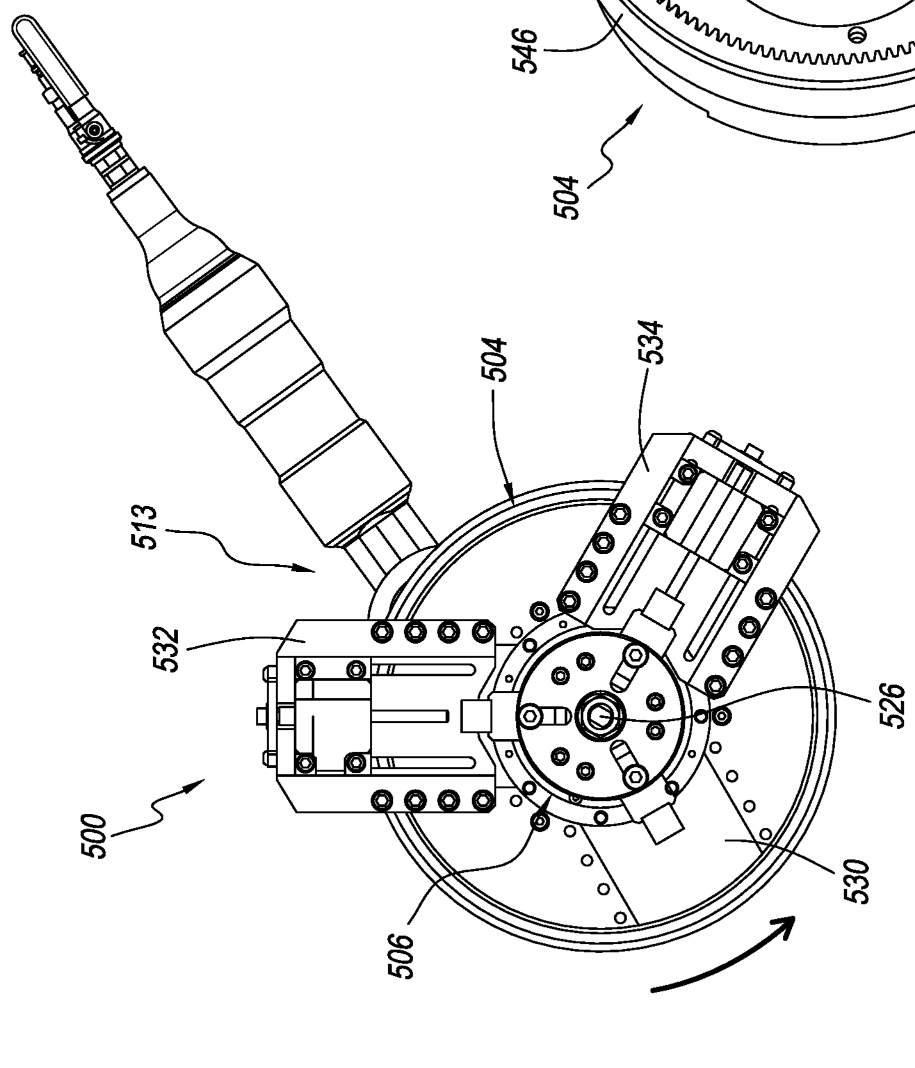


FIG. 22

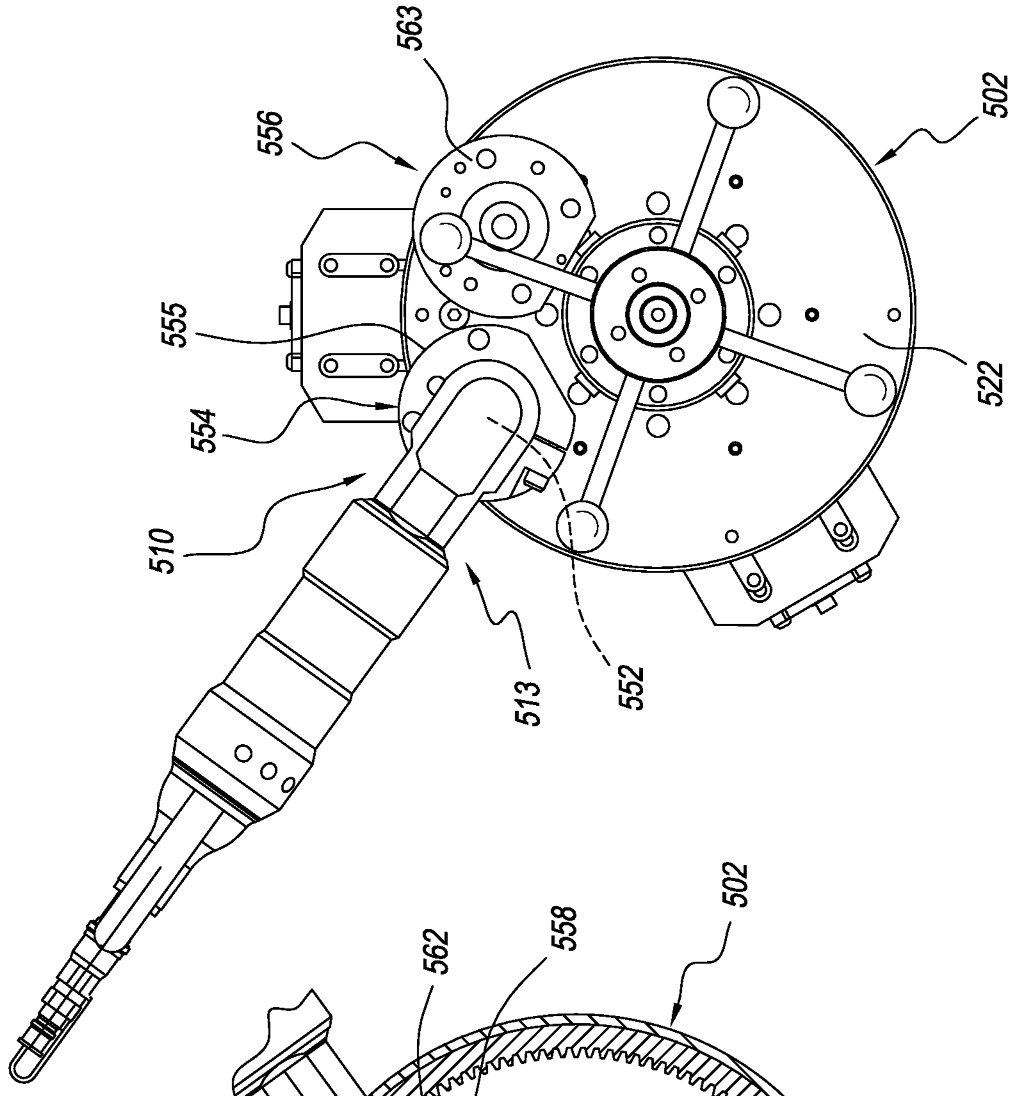

563
556
502
555
554
510
513
552
522

FIG. 25

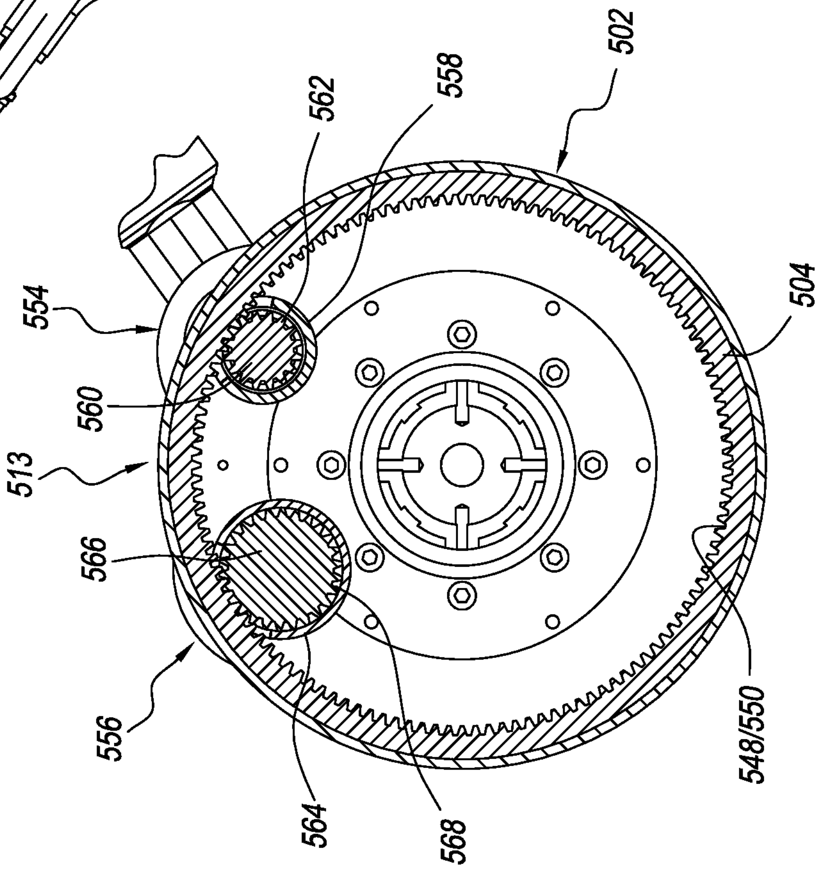
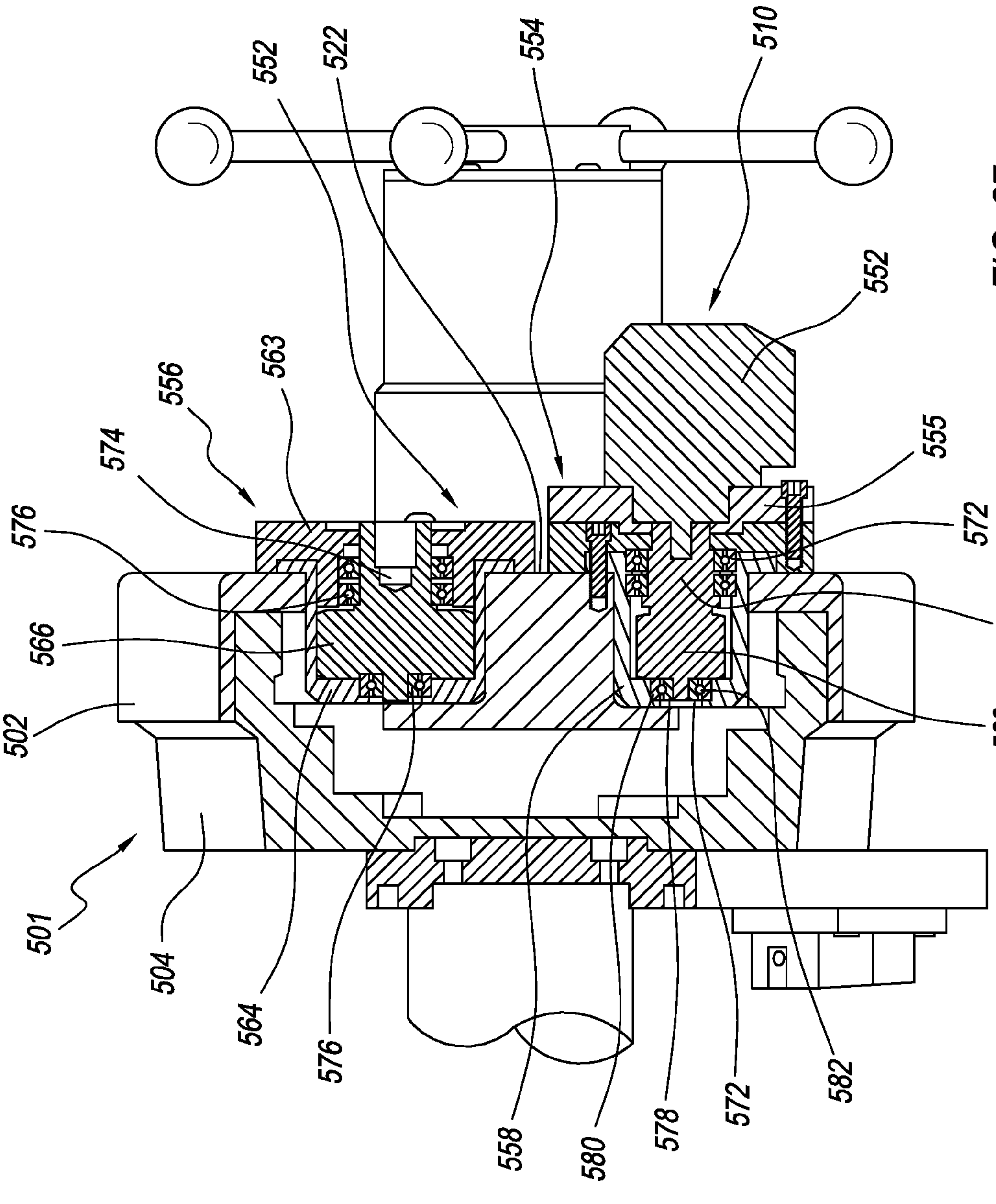

502
558
562
554
504
560
513
566
556
564
568
548/550

FIG. 26


501
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504
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522
552
552
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555
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558
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563
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572
572
574
576
576
578
580
582

FIG. 27

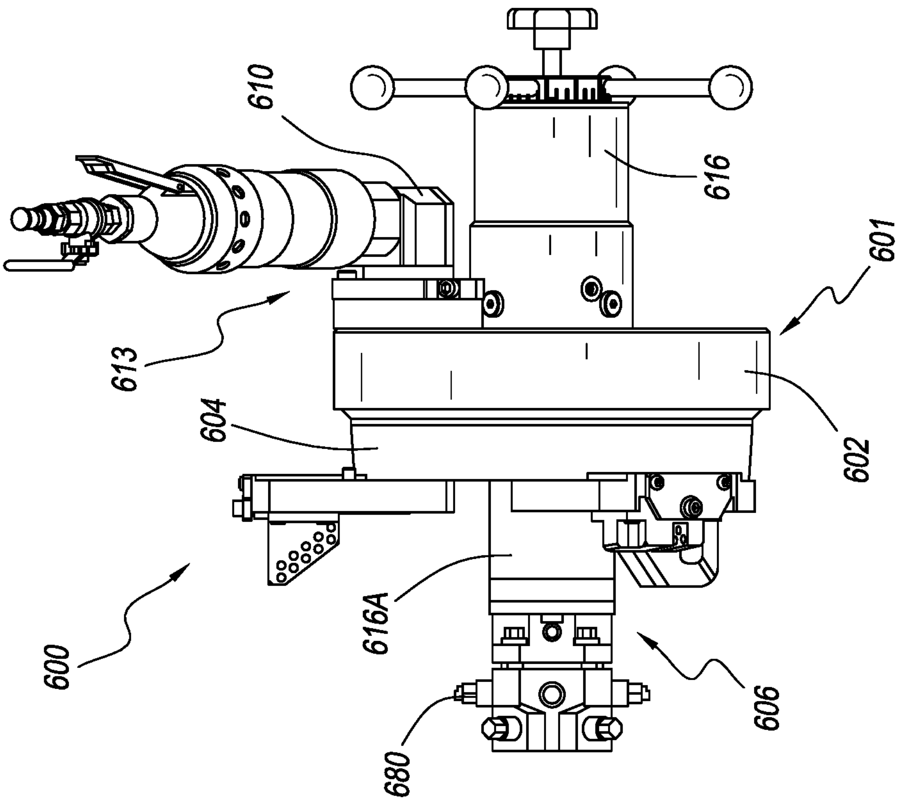
610
616
601
613
604
602
600
616A
606
680

FIG. 28

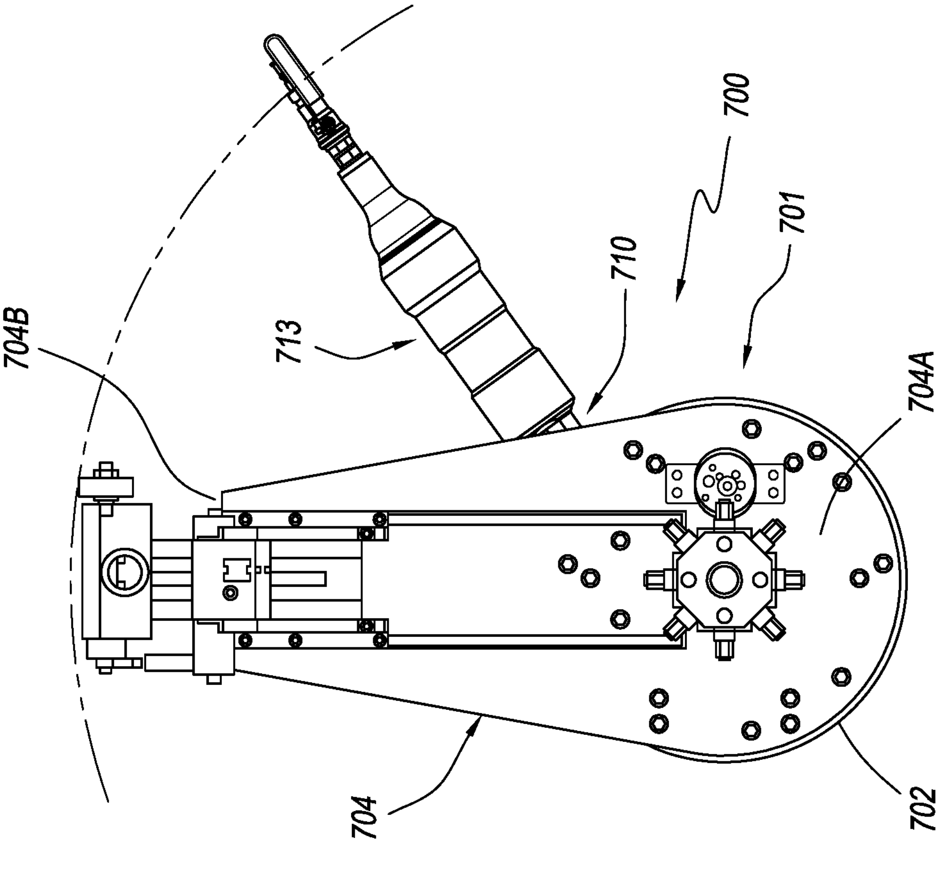
700
701
710
704B
713
704A
704
702

FIG. 29

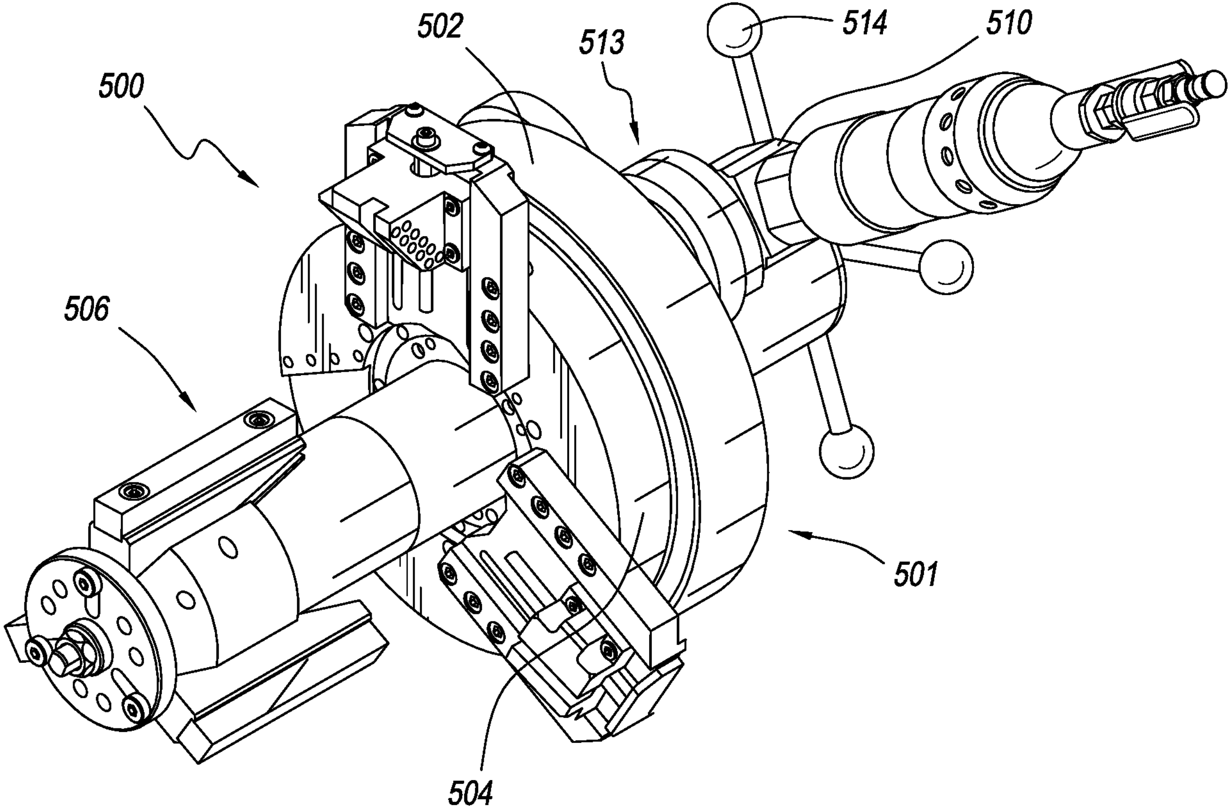

FIG. 20