(19) DANMARK

(10) **DK/EP 3618983 T3**

Patent- og Varemærkestyrelsen

(12) Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***B 21 D 17/04 (2006.01)*** ***B 21 H 1/18 (2006.01)*** ***B 21 H 7/18 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2023-08-07**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2023-06-07**

(86) Europæisk ansøgning nr.: **18794800.5**

(86) Europæisk indleveringsdag: **2018-02-26**

(87) Den europæiske ansøgnings publiceringsdag: **2020-03-11**

(86) International ansøgning nr.: **US2018019622**

(87) Internationalt publikationsnr.: **WO2018203963**

(30) Prioritet: **2017-05-03 US 201715585457**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **Victaulic Company, 4901 Kesslersville Road, Easton, PA 18040, USA**

(72) Opfinder: **DOLE, Douglas, R., 9 Minsi Road, Whitehouse Station, NJ 08889, USA**

(74) Fuldmægtig i Danmark: **Patrade A/S, Ceresbyen 75, 6., 8000 Århus C, Danmark**

(54) Benævnelse: **KAMSKIVERILLEMASKINE MED KAMSKIVESTOPOVERFLADER**

(56) Fremdragne publikationer:
US-A- 2 686 442
US-A- 3 387 477
US-A- 3 686 917
US-A- 5 291 769
US-A- 5 435 213
US-A1- 2002 007 514
US-A1- 2004 221 635
US-A1- 2006 011 017

DESCRIPTION

Field of the Invention

[0001] This invention relates to machines using cams to cold work pipe elements.

Background

[0002] Cold working of pipe elements, for example, impressing a circumferential groove in a pipe element to accept a mechanical pipe coupling, is advantageously accomplished using roll grooving machines having an inner roller which engages an inside surface of the pipe element and an outer roller which simultaneously engages an outside surface of the pipe element opposite to the inner roller. As the pipe is rotated about its longitudinal axis, often by driving the inner roller, the outer roller is progressively forced toward the inner roller. The rollers have surface profiles which are impressed onto the pipe element circumference as it rotates, thereby forming a circumferential groove.
US 2,686,442 A describes the art of metal working, and, more particularly, to a machine for roll-die formation of shapes from cylindrical billets, such as "dumbbell" contoured shapes as commonly used in the manufacture of turbine blades and other products.

[0003] There are various challenges which this technique faces if it is to cold work pipe elements with the required tolerances to the necessary precision. Most pressing are the difficulties associated with producing a groove of the desired radius (measured from the center of the pipe element bore to the floor of the groove) within a desired tolerance range. These considerations have resulted in complicated prior art devices which, for example, require actuators for forcing the rollers into engagement with the pipe element and the ability for the operator to adjust the roller travel to achieve the desired groove radius. Additionally, prior art roll grooving machines have low production rates, often requiring many revolutions of the pipe element to achieve a finished circumferential groove. There is clearly a need for devices, for example, those using cams, to cold work pipe elements which are simple yet produce results with less operator involvement.

Summary

[0004] The invention is defined by a device for cold working a pipe element, said device comprising:

a housing;

a plurality of gears mounted within said housing, each one of said gears being rotatable about a respective one of a plurality of axes of rotation, said axes of rotation being parallel to one another, said gears being positioned about a central space for receiving said pipe element;

a plurality of cam bodies, each said cam body mounted on a respective one of said gears;

a plurality of cam surfaces, each one of said cam surfaces extending around a respective one of said cam bodies and being engageable with said pipe element received within said central space, each one of said cam surfaces comprising a region of increasing radius and a discontinuity of said cam surface, each one of said radii being measured about and from a respective one of said axes of rotation;

characterized in that,

at least one traction surface extending around one of said cam bodies said at least one traction surface comprising a plurality of projections extending transversely to said axis of rotation of said one cam body, said at least one traction surface having a gap therein, said gap being aligned axially with said discontinuity of one said cam surface surrounding said one cam body;

at least one stop surface projecting from one of said cam bodies transversely to said axis of rotation of one of said gears, said at least one stop surface positioned adjacent to said discontinuity of said cam surface on said one cam body;

a pinion mounted within said central space within said housing, said pinion meshing with said plurality of gears and being rotatable about a pinion axis oriented parallel to said axes of rotation;

a cup adjacent said pinion, said cup receiving said pipe element upon insertion of said pipe element into said central space; wherein

said cup is movable relatively to said housing along said pinion axis between a first position, wherein said cup engages said stop surface thereby preventing continuous rotation of said cam bodies, and a second position, wherein said cup is out of engagement with said stop surface, thereby permitting continuous rotation of said cam bodies. Further embodiments of the invention are as defined by the dependent claims.

Brief Description of the Drawings

[0005]

Figure 1 is an isometric view of an example embodiment of a device according to the invention;

Figure 2 is an exploded isometric view of a portion of the device shown in Figure 1;

Figure 3 is an exploded isometric view of components of the device shown in Figure 1;

Figure 3A is a longitudinal sectional view of the device shown in Figure 1;

Figure 4 is an exploded isometric view of components of the device shown in Figure 1;

Figure 4A is an end view of an example cam according to the invention;

Figure 4B is a side view of an example cam according to the invention;

Figure 4C is an end view of an example cam according to the invention;

Figure 4D is an isometric view of an example cam according to the invention;

Figure 5 is a cross sectional view of device 10 taken at line 5-5 of Figure 1;

Figures 6 through 9 and 9A are additional cross sectional views illustrating operation of device 10;

Figures 6A and 6B are isometric views of a portion of the device shown in Figure 1 illustrating operation of the stop surfaces on the cams;

Figures 10-12 are cross sectional views illustrating a safe reverse mode of the device 10 when a pipe element is rotated in the wrong direction;

Figure 13 is a partial view of another example embodiment of a device according to the invention;

Figure 14 is an end view of another example cam according to the invention;

Figures 15 and 16 are isometric views of example embodiments of devices according to the invention; and

Figure 17 is an isometric view of another example embodiment of a device according to the invention.

Detailed Description

[0006] Figure 1 shows an example device 10 for cold working a pipe element, for example, forming a circumferential groove in the pipe element's outer surface. Device 10 is shown pivotably mounted on a rotating power chuck 12. Such chucks are well known, an example being the Ridgid 300 Power Drive marketed by Ridgid of Elyria, Ohio.

[0007] Figure 2 shows an exploded view of device 10 which comprises a housing 14. Housing 14 is formed of a housing body 16 and a cover 18. A plurality of gears, in this example three gears 20, 22 and 24 are rotatably mounted on respective shafts 26, 28 and 30, the shafts being supported by the housing body 16 and cover 18 and defining respective axes of rotation

32, 34 and 36. Axes 32, 34 and 36 are arranged parallel to one another. In a practical design each gear 20, 22 and 24 has a respective flanged bushing 38, and may also have a thrust washer 40 and a compression spring 42. The compression springs 42 act between the gears 20, 22 and 24 and the cover 18 to bias the gears away from the cover.

[0008] Gears 20, 22 and 24 are positioned about a central space 44 which receives a pipe element 136 to be cold worked by the device 10. An opening 46 in cover 18 provides access to the central space 44 and permits pipe element insertion into the device 10. As shown in Figures 2, 3 and 3A, a pinion 48 is mounted on housing body 16 within the central space 44. Pinion 48 meshes with gears 20, 22 and 24 and thus synchronizes the motion of the gears 20, 22 and 24 and their associated cam bodies as described below. In this example pinion 48 comprises a pinion shaft 50 which defines a pinion axis of rotation 52 oriented parallel to the axes 32, 34 and 36 of the gears 20, 22 and 24. Pinion shaft 50 is supported by a flanged pinion bushing 54 fixedly attached to the housing body 16. In a practical design, a thrust bearing 56 and thrust washers 58 are interposed between the pinion 48 and the housing body 16.

[0009] For ease of assembly the pinion shaft 50 in this example is retained within the housing 14 by a retaining ring 60 (see Figure 3A) which is received within a circumferential groove 62 in the pinion shaft 50. Ring 60 engages the bushing 54 when present. One or more springs 66 may act between the housing body 16 and the thrust washer 58 (see Figure 2) to bias the pinion toward the housing cover 18, motion in that direction being limited by the engagement between the retaining ring 60 and the bushing 54. Alternately, contact with a vertical portion of one of the cam bodies may also be used to limit pinion shaft travel (see Figure 3A). Attaching the pinion 48 using springs 66 and retaining ring 60 allows the pinion to move relatively to housing 14 in a direction along the pinion axis 52. This axial motion of the pinion 48 is used to lock and unlock the cam bodies to permit or prevent their rotational motion as described below.

[0010] To provide contact between the pinion 48 and the pipe element, a cup 68 is positioned adjacent the pinion 48 and is captured between the cam bodies. In a practical design the cup 68 may be fixedly attached to the pinion as shown in Figure 3A, or freewheeling as shown in Figures 2 and 4. As further shown in Figure 4, a spring 67 may be positioned between the pinion 48 and the cup 68 to bias the cup, which is movable within the housing 14 in a direction along the pinion axis 52. Axial motion of the cup 68 is used to lock and unlock the pinion to permit or prevent rotational motion of the cam bodies as described below. Cup 68 receives and maintains the pipe element in alignment with the pinion 48 so that it may be turned when cold working the pipe element as described below. Cup 68 also helps limit pipe end flare during cold working.

[0011] As shown in Figure 4, device 10 comprises a plurality of cams 69, in this example, three cams having respective cam bodies 70, 72 and 74. Each cam body 70, 72 and 74 is mounted on a respective gear 20, 22 and 24. Each cam body 70, 72 and 74 comprises a respective cam surface 76, 78 and 80. Each cam surface 76, 78 and 80 extends around their respective cam body 70, 72 and 74. The cam surfaces 76, 78 and 80 are engageable with a pipe element received within the central space 44.

[0012] As shown in detail in Figure 4A, each one of the cam surfaces 76, 78, 80 (76 shown) comprises a region 82 of increasing radius 82a and a discontinuity 86. Each one of the cam surfaces may also include a region 84 of constant radius 84a positioned adjacent to the discontinuity 86. The radii 82a and 84a (when present) are measured about and from the respective axes of rotation 32, 34 and 36 of the gears 20, 22 and 24 (shown for the cam surface 76, the axis 32 of gear 20). As shown in Figure 5, the discontinuities 86, when facing the central space, provide clearance permitting insertion of the pipe element into the cup 68. With reference again to Figure 4A, the example device 10 has three cam bodies 70, 72 and 74. The regions of constant radius 84 extend along an arc length which is at least 1/3 of the circumference of the finished circumferential groove in the pipe element so that the groove may be formed to a uniform radius around the entire circumference of the pipe element during one revolution of each cam body 72, 74 and 76. In an example practical design (see Figure 4A), the region of increasing radius 82 may subtend an angle 88 of approximately 260°, and the region of constant radius (when present) may subtend an angle 90 of approximately 78°, the discontinuity 86 subtending an angle 92 of approximately 22°. For devices 10 having a number of cams other than three and the constraint that the groove be formed to a uniform radius around the entire circumference of the pipe element in one revolution of each of the cams, the arc length of the region of constant radius of each cam body is advantageously 1/N, where "N" is the number of cams in the design. However, it is feasible to reduce or eliminate entirely the region of constant radius. Elimination of this region will reduce the torque required to form the groove.

[0013] As shown in Figures 4 and 4B, it is advantageous to include at least one traction surface 94 on one of the cam bodies such as 70. In the example device 10 each cam body 70, 72 and 74 has a respective traction surface 94, 96 and 98. The traction surfaces 94, 96 and 98 extend circumferentially around their respective cam bodies 70, 72 and 74 and have a constant radius measured about and from the respective axes of rotation 32, 34 and 36. The cam surfaces 76, 78, 80, are positioned between the gears 20, 22 and 24 and the traction surfaces 94, 96 and 98, the cam surfaces being positioned proximate to the traction surfaces. As shown in Figure 4B, each traction surface (94 shown) comprises a plurality of projections 100 which extend transversely to the respective axes of rotation 32, 34 and 36. Projections 100 provide mechanical engagement and purchase between the cam bodies 70, 72 and 74 and the pipe element which the traction surfaces engage. Each traction surface 94, 96 and 98 also has a gap 102. Each gap 102 in each traction surface 94, 96 and 98 substantially aligns axially with a respective discontinuity 86 in each cam surface 76, 78, 80 to provide clearance permitting insertion and withdrawal of the pipe element into and from the cup 68. In another cam embodiment 69a, shown in Figure 4D, the traction surface 94 overlies the cam surface 76. The gap 102 in the traction surface 94 is again aligned with the discontinuity 86 in the cam surface 76.

[0014] As shown in Figures 4B and 4C, one or more stop surfaces 71, 73 project from at least one of the cam bodies (70 shown). First and second stop surfaces 71 and 73 project transversely to the cam body axis of rotation 32 and are positioned adjacent to the discontinuity 86 of the cam surface 76. In the practical example shown in Figures 4B and 4C, the stop surfaces 71 and 73 are positioned on the first and second ends 75, 77 of a rib 79. Rib 79 extends circumferentially around the cam body 70 between the gear 20 and the cam surface 76. Stop surfaces 71 and 73 may have concave curvature 81 as shown in Figure 4C to better cooperate with cup 68 during operation of the device 10 as described below. While the stop surfaces 71, 73 are illustrated and described for cam body 70, it is understood that the same stop surfaces may also be present on cam bodies 72 and 74 as well.

[0015] As shown in Figure 5, it is further advantageous to include an actuator 106 to initiate motion of the cam bodies 70, 72 and 74. In this example embodiment, actuator 106 comprises an actuator lever 108 pivotably mounted on the housing body 16. Actuator lever 108 has a first surface 110 which engages a finger 112 on cam body 74 to initiate rotation of the cam body. Finger 112 is offset from the axis of rotation 36 of cam body 74 and extends from cam body 74 in a direction parallel to the axis 36 (see also Figure 2). The offset of finger 112 allows the actuator lever 108, when pivoted about its pivot axis 108a (aligned parallel to the pinion axis 52), to apply a torque to the cam body 74 (gear 24) and rotate it about axis 36. This rotates all of the cam bodies 70, 72 and 74 because their respective gears 20, 22 and 24 mesh with the pinion 48 which provides a synchronization function, thus the act of turning any one gear or turning the pinion turns all gears. Actuator lever 108 also has a second surface 114 which is engaged by the finger 112 as the cam body 74 rotates. The second surface 114 is curved in this example and allows the rotating cam body 74 to reset the relative positions of the finger 112 and the actuator lever 108 so that upon one rotation of the cam body 74 the actuator lever 108 is pivoted to a "ready" position as shown in Figure 6, ready to apply a torque to the cam body and initiate rotation.

[0016] It is further advantageous to include a stop 116, movably mounted on housing body 16 to prevent motion of the cam bodies. In this example embodiment, stop 116 comprises a hook 118 pivotably mounted on the housing body 16 with a pivot axis 118a aligned parallel to the pinion axis 52. Hook 118 engages a finger 120 on cam body 70 (gear 20). Finger 120 is offset from the axis of rotation 32 of cam body 70 and extends from cam body 70 in a direction parallel to the axis 32 (see also Figure 2). The offset allows the hook 118 to arrest counter clockwise motion of cam body 70 as described below. Tangent surfaces 122 and 124 are positioned at the end of hook 118 for engagement with finger 120 during operation of the device as described below. A torsion spring 126 (see also Figure 2) acts between the hook 118 and the housing body 16 to bias the hook in a counter clockwise direction around pivot axis 118a. Hook 118 also has a spur 128 which extends to the opposite side of the pivot axis 118a from the hook (see also Figures 2 and 4). Actuator lever 108 has a foot 130 which engages spur 128 to pivot the hook 118 out of engagement with finger 120 upon movement of the actuator lever 108 into engagement with the finger 112, forcing the cam 74 counterclockwise to initiate motion of the cam bodies 70, 72 and 74 as described below.

[0017] Operation of device 10 begins with the cam bodies 70, 72 and 74 aligned as shown in Figure 6 such that the discontinuities 86 in the cam surfaces 76, 78 and 80 (see also Figure 4) and gaps 102 in the traction surfaces 94, 96 and 98 simultaneously face the pinion axis 52. As further shown in Figure 6A, cup 68 is biased axially, either by springs 66 (see Figure 3A) or spring 67 (see Figure 4) into a first position wherein the cup engages the first stop surface 71 on cam body 72. When cup 68 is in this position the cam bodies 70, 72 and 74 are prevented from rotating about their respective axes 32, 34 and 36. As shown in Figure 1, device 10 is mounted on tubes 132 extending from one end of the rotating chuck 12. The opening 46 in housing cover 18 faces the chuck 12 (see Figure 2). Pinion axis 52 is coaxially aligned with the axis of rotation 134 of chuck 12. A pipe element 136 is inserted into the opposite end of the chuck 12 so that the end of the pipe element extends outwardly from the chuck toward device 10. Chuck 12 is tightened to secure the pipe element and the device 10 is then moved along tubes 132 toward and into engagement with the pipe element.

[0018] With reference to Figures 2 and 4, the pipe element passes through opening 46 and into the central space 44. Aligned discontinuities 86 and gaps 102 provide the clearance necessary to permit the pipe element to pass by cam surfaces 76, 78 and 80 and traction surfaces 94, 96 and 98 to be received in the cup 68. The pipe element is thus aligned with the pinion axis 52. Device 10 is moved further toward chuck 12 (see Figure 1) so as to cause the cup 68 to move axially along the pinion axis 52 and compress springs 66 (see Figure 2) or spring 67 (see Figure 4) sufficiently to move cup 68 into the second position shown in Figure 6B where the cup is not engaged with the stop surface 71 on cam body 72 or any other cam body. When cup 68 is in this second position, rotation of the cam bodies 70, 72 and 74 is permitted. The chuck 12 is then actuated, which rotates the pipe element clockwise as viewed in Figures 5 and 6. Alternately, rotation of the pipe element can be initiated and then the device 10 can be slid into engagement with the pipe element.

[0019] Engagement between the pipe element and the cup 68, when the cup is not fixed to the pinion, may cause the cup to rotate clockwise with the pipe. When the cup 68 is freewheeling relative to the pinion 48, the torque transmitted via friction between the cup 68 and the pinion 48 may try to rotate the pinion, and consequently gears 20, 22 and 24. Motion of the gears is easily prevented by engagement between the hook 118 and the finger 120 extending from cam body 70 (gear 20). There is furthermore no significant engagement between the pipe element and the cam bodies because the discontinuities 86 in the cam surfaces 76, 78 and 80 (see also Figure 4) and gaps 102 in the traction surfaces 94, 96 and 98 simultaneously face the pinion axis 52 and do not significantly contact the pipe at this time. If the cup 68 is fixedly attached to the pinion 48 then engagement between hook 118 and finger 120 again prevents motion of the gears and pinion, the pipe element merely rotates within the cup.

[0020] To initiate gear and cam body rotation, actuator lever 108 is depressed, causing it to pivot counterclockwise about its axis 108a as viewed in Figure 6. As shown in Figure 7, pivoting of actuator lever 108 causes its first surface 110 to engage the finger 112 extending from cam body 74, and also causes the foot 130 to engage the spur 128 of the hook 118. Hook 118 pivots clockwise about its axis 118a and winds its biasing spring 126 (see also Figure 2). The geometry of the actuator lever 108, hook 118 and its spur 128 is designed such that finger 120 on cam body 70 is released from the hook 118 as torque is applied to rotate cam body 74 via engagement of the first surface 110 of actuator lever 108 with finger 112. Figure 7 shows finger 120 on the verge of release from hook 118 and cam body 74 just before engagement with the pipe element. As shown in Figures 8 and 4, further pivoting of the actuator lever 108 pivots the hook 118 and releases the finger 120 from hook, (thereby permitting motion of the gear 20) while applying torque to the cam body 74 (gear 24) to initiate rotation of the pinion 48 and gears 20, 22 and 24 and their associated cam bodies 70, 72 and 74. The cam bodies rotate counter clockwise and their cam surfaces 76, 78 and 80 and traction surfaces 94, 96 and 98 engage the outer surface of the pipe element. The cam bodies 70, 72 and 74 are then driven by the rotating pipe element. The regions of increasing radius 82 (see Figure 4A) of the cam surfaces 76, 78 and 80 first engage the pipe element and begin to form a circumferential groove in it as the cam bodies 70, 72 and 74 rotate. The traction surfaces 94, 96 and 98 (see Figure 4B) also engage the pipe element and provide mechanical engagement which prevents slippage between the cam surfaces 76, 78 and 80 and the pipe element. As the radius at the point of contact between the cam surfaces and the pipe element increases, the groove radius is made smaller until the point of contact transitions to the region of constant radius 84 (Figure 4A) of each cam surface 76, 78 and 80. For a device 10 having three cam bodies with respective regions of constant radius, each region of constant radius 84 extends over at least 1/3 of the circumference of the finished circumferential groove in the pipe element. The radius of the region of constant radius is designed to impart the final desired groove radius to the circumferential groove in the pipe element at a uniform radius around the entire circumference of the pipe element with one revolution of all three cam bodies. Alternately, when the regions of constant radius are not present on the cams, the groove radius is not uniform, but form separate partial spirals, one for each cam. Although not uniform, the radius of the groove falls within the necessary tolerances for the groove's intended use.

[0021] As shown in Figures 9 and 9A, cam body 74 nears completion of its single revolution and the finger 112 contacts the second (curved) surface 114 of the actuator lever 108. Interaction between finger 112 and surface 114 causes the actuator lever 108 to pivot clockwise about its pivot axis 108a and return to the starting position shown in Figure 6. Hook 118 follows, biased by the spring 126 to pivot counterclockwise into a position ready to receive the finger 120. When continued rotation of cam body 70 occurs it moves finger 120 into hook 118 which stops motion of the gears 20, 22 and 24. It is also feasible to design spring 126 to have sufficient stiffness such that it will pivot both the hook 118 and the actuator lever 108 back into the start position shown in Figure 6 when the actuator lever is released. Upon completion of groove formation the chuck 12 is stopped and the pipe element, now grooved, may be removed from device 10. Cup 68, biased either by springs 66 (see Figure 2) or spring 67 (see Figure 4) moves axially into the first position (see Figure 6A) where it is in engagement with one or more of the stop surfaces 71.

[0022] Figures 10-12 illustrate an anomalous condition wherein the pipe element is inadvertently rotated counterclockwise. This may happen due to operator error, as power chucks such as the Ridgid 300 are capable of applying significant torque in both directions.

[0023] If reverse torque (i.e., torque which will rotate the pipe element counterclockwise as viewed in Figure 10) is applied before the pipe element has been grooved, the pipe element will merely rotate relative to the cam bodies 70, 72 and 74 and their associated gears 20, 22 and 24 because the discontinuities 86 in the cam surfaces 76, 78 and 80 (see also Figure 4) and gaps 102 in the traction surfaces 94, 96 and 98 simultaneously face the pinion axis 52 and thus neither surface contacts the pipe element. Additionally the ends of the discontinuities in the cam surfaces, being at the end of the region of constant radius 84, are too steep for the pipe element to climb through frictional contact even if the pipe element and the cam surfaces come into contact. Depressing the actuator lever 108 will have no significant effect, as this action will try to rotate the cams and gears in the opposite direction from how the pipe element, rotating under reverse torque, will try to turn the cam bodies via friction between the cup 68 and pinion 48 when the cup is not fixedly attached to the pinion.

[0024] However, if reverse torque is inadvertently applied after a pipe element has been grooved, the regions of constant radius 84 of the cam surfaces 76, 78 and 80 are at approximately the same radius as the floor of the groove and thus will gain purchase and rotate the cam bodies 70, 72 and 74 clockwise. The torque on the cam bodies (and their associated gears 20, 22 and 24) will be augmented when the pipe element further contacts the traction surfaces 94, 96 and 98. As significant torque is applied to the pipe element, measures are taken to prevent damage to the device 10.

[0025] Figures 10-12 illustrate the condition wherein reverse torque is applied to a pipe element which has already been grooved. As shown in Figure 10, the cam bodies 70, 72 and 74 are driven clockwise. The finger 120 on cam body 70 is moved away from the hook 118, but the finger 112 of cam body 74 is driven against the actuator lever 108. Actuator lever 108 is free to pivot clockwise in response to this applied force, the pivoting motion allowing the finger 112 to fall off of the first surface 110 of the actuator lever 108 and engage the second (curved) surface 114, thereby avoiding any damage to device 10. As shown in Figure 11, the cam bodies continue to rotate clockwise and the finger 120 of cam body 70 comes into contact with the first of the two tangent surfaces 122 and 124 on the end of hook 118. As shown in Figure 12, the first tangent surface 122 is angularly oriented such that it permits the finger 120 to pivot the hook 118 clockwise against its biasing spring 126 in response to the force applied by the finger 120. Pivoting motion of the hook 118 further prevents damage to the device 10. As the finger 120 transitions to the second tangent surface 124 the hook 118 is permitted to pivot counterclockwise under the force of its biasing spring 126 and move again to the ready position shown in Figure 10, as does the finger 112 on cam body 74. This motion will repeat until the motion of the pipe element is stopped.

[0026] Figure 13 shows another example embodiment of a device 138 according to the invention having at most two gears 140, 142. Gears 140, 142 are mounted within a housing 144 for rotation about respective axes 146, 148. Axes 146, 148 are oriented parallel to one another. A pinion 150 is mounted on housing 144 within a central space 152 which receives a pipe element for processing. Pinion 150 meshes with gears 140, 142 and rotates about a pinion axis 154 oriented parallel to axes 146 and 148.

[0027] Cam bodies 156, 158 are respectively mounted on gears 140, 142. As shown in Figure 14, each cam body (156 shown) comprises a plurality of cam surfaces, in this example, two cam surfaces 160 and 162. Other cam embodiments, including cams having a single cam surface or cams having more than two cam surfaces are also feasible. The cam surfaces 160 and 162 extend around the respective cam bodies 156 and 158 and are engageable with the pipe element received within the central space 152. The cam surfaces 160 ad 162 are circumferentially aligned with one another. Each cam surface 160, 162 comprises a respective region of increasing radius 164 and a region of constant radius 166. The radii are respectively measured about and from the axes of rotation 146 and 148. Respective discontinuities 168, 170 are positioned between each cam surface 160, 162 on each cam body 156, 158.

[0028] Figure 13 also shows a plurality of stop surfaces 157, 159 on each cam body 158, 159. Stop surfaces 157, 159 project transversely to respective cam body axes of rotation 146 and 148 and are positioned adjacent to discontinuities 168, 158 in the cam surfaces 160, 162. Stop surfaces 157, 159 on each cam body 158, 159 are respectively positioned between gears 140, 142 and cam surfaces 160 and 162.

[0029] As further shown in Figure 14, a plurality of traction surfaces, in this example two traction surfaces 172, 174, extend around each cam body 156, 158 (156 shown). Traction surfaces 172, 174 are circumferentially aligned with one another in this example. Traction surfaces 172, 174 each comprise a plurality of projections 176 which extend transversely to respective axes of rotation 146, 148. Respective gaps 178, 180 are positioned between each traction surface 172, 174 on each cam body 156, 158. Gaps 178, 180 are respectively aligned with discontinuities 168, 170 in the cam surfaces 160, 162. As in the earlier discussed embodiment, the cam surfaces 160, 162 on each cam body 156, 158 may be positioned, between the respective gears 140, 142 and the traction surfaces 172, 174, and the cam surfaces may be located proximate to the traction surfaces on each cam body.

[0030] Cams having a plurality of cam surfaces and traction surfaces are sized so that they form a complete circumferential groove for a fraction of a rotation. For example, cams 182 as illustrated in Figures 13 and 14 having at most two cam surfaces and two traction surfaces form a complete circumferential groove in one half a revolution of the cams.

[0031] Although devices having 2 and three cams are illustrated herein, designs having more than three cams are advantageous for forming grooves having a consistent radius, especially in pipe elements having a nominal pipe size of 2 inches or greater, or for pipe elements of any size having a variety of wall thicknesses.

[0032] Figure 15 shows another embodiment 184 of a device for cold working pipes. Embodiment 184 comprises a housing 14 in which cams 69 (shown) or cams 182 are rotatably mounted and mesh with a pinion 48. In this embodiment an electrical motor 186 is coupled to the pinion, either directly or through a gear box. In this arrangement it is advantageous if the electrical motor 186 is a servomotor or a stepper motor. A servomotor or a stepper motor allows for precise control of the number of revolutions of the cams 69 so that the discontinuities in the cam surfaces and the gaps in the traction surfaces are aligned at the beginning and end of the grooving procedure so that the pipe element can be inserted and removed easily. Control of the electrical motor 186 is effected using a programmable logic controller 188 or other similar microprocessor based computer.

[0033] Figure 16 illustrates another device embodiment 190 wherein a clutch 192 operates between the electrical motor 186 and the pinion 48. In this example, motor 186 is coupled to the clutch 192 through a reduction gear 194. The clutch 192 engages the pinion 48 through a link chain shaft coupling 196 which compensates for misalignment between the clutch and the pinion. Clutch 192 is a wrapped spring type, examples of which are commercially available from Inertia Dynamics of New Hartford, CT. Wrapped spring clutches are readily adjustable to engage and disengage automatically as needed to produce a desired number of revolutions of pinion 48 to achieve a number of revolutions of the cams 69 required to form a circumferential groove and have the discontinuities of the cam surfaces and gaps in the traction surfaces facing the pinion at the end of the grooving process.

[0034] Figure 17 illustrates another example device embodiment 198 wherein the device is supported directly on the pipe element 136 being cold worked. Pipe element 136 is, in turn, supported on a pipe vise 200 or other convenient support means which will prevent the pipe element from turning when torque is applied about its axis 202. Device 198 is substantially similar to device 10 described above, but has a crank 204 coupled with the pinion 48 for manually turning the pinion, and thereby gears 20, 22 and 24 and their associated cam bodies 70, 72, 74, cam surfaces 76, 78, 80 and traction surfaces 94, 96, 98 (see also Figure 2) to form a groove of uniform radius over the entire circumference of the pipe element 136. Crank 204 may be coupled to the pinion 48 by directly engaging the pinion shaft 52 (a "direct" coupling between the crank and the pinion), or a gear train (not shown) may be interposed between the crank and the pinion shaft to reduce the torque required for manual operation.

[0035] In operation (see Figures 2 and 17) the pipe element 136 is affixed to the pipe vise 200 and the opening 46 in the cover 18 of the housing 14 is aligned with the pipe axis 202. The opening 46 is then engaged with the pipe element 136 and the housing 14 is slid onto the pipe element, which enters the central space 44 and is received within the cup 68 to seat the end of the pipe element 136 to the proper depth within the device 198 so that the groove is formed at the desired distance from the end of the pipe element. Optionally, to ensure proper pipe element seating, device 198 may be equipped with the axially movable cup 68 or pinion 48 as described above. When this feature is present the housing 14 is further forced toward the pipe element to move the pinion 48 or cup 68 axially and disengage the cup from the stop surface or surfaces on the cam bodies. Turning of the crank 204 will then turn the pinion 48, which will turn the cams 69 through the gears 20, 22 and 24 meshing with the pinion 48. Rotation of the gears engages the cam surfaces 76, 78 and 80 and the traction surfaces 94, 96 and 98 with the pipe element and the device 198 rotates about the pipe element 136 to form a circumferential groove of uniform radius. Upon one rotation of the cams 69 the groove is complete, and this condition is signaled to the operator by an abrupt decrease in the torque required to turn the crank 204. With the gaps 102 in the traction surfaces and the discontinuities 86 in the cam surfaces facing the pipe element 136, clearance is provided and the device 198 may be removed from the pipe element. The grooved pipe element may then be removed from the vise 200.

[0036] Devices according to the invention are expected to operate effectively and cold work pipe elements to the desired dimensional tolerances with precision while operating more quickly and simply without the need for operator intervention.

REFERENCES CITED IN THE DESCRIPTION

Cited references

Patent documents cited in the description

- US2686442A [0002]

Patentkrav

1. En anordning (10) til koldbearbejdning af et rørelement (136), anordningen (10) omfatter:

et hus (14);

en flerhed af tandhjul (20, 22, 24) monteret inden i huset (14), hvor hvert af tandhjulene (20, 22, 24) kan drejes omkring en respektive af en flerhed af rotationsakser (32, 34, 36), hvor rotationsakserne (32, 34, 36) er parallelle med hinanden, og hvor tandhjulene (20, 22, 24) er placeret omkring et centralt rum (44) til at modtage rørelementet (136);

en flerhed af kamskivelegemer (70, 72, 74), hvert kamskivelegeme (70, 72, 74) monteret på et af de respektive tandhjul (20, 22, 24);

en flerhed af kamskiveoverflader (76, 78, 80), hver af kamskiveoverfladerne (76, 78, 80) strækker sig rundt om et af de respektive kamskivelegemer (70, 72, 74) og kan komme i indgreb med rørelementet (136) modtaget i det centrale rum (44), hver af kamskiveoverfladerne (76, 78, 80) omfatter et område (82) med stigende radius (82a) og en diskontinuitet (86) i kamskiveoverfladen (76, 78, 80), hver af radierne (82a) måles omkring og fra en af de respektive rotationsakser (32, 34, 36); **kendetegnet ved, at**

mindst en traktionsoverflade (94, 96, 98) der strækker sig rundt om et af kamskivelegemerne (70, 72, 74), den mindst ene traktionsoverflade (94, 96, 98) omfatter en flerhed af fremspring (100) strækker sig på tværs af rotationsaksen (32, 34, 36) af det ene kamskivelegeme (70, 72, 74), den mindst ene traktionsoverflade (94, 96, 98) har et mellemrum (102) deri, mellemrummet (102) er justeret aksialt med diskontinuiteten (86) af den ene kamskiveoverflade (76, 78, 80) omgivende det ene kamskivelegeme (70, 72, 74);

mindst en stopoverflade (71, 73), der rager ud fra et af kamskivelegemerne (70, 72, 74) på tværs af rotationsaksen (32, 34, 36) af et af tandhjulene (20, 22, 24), den mindst ene stopoverflade (71, 73) er placeret tilstødende til diskontinuiteten (86) i kamskiveoverfladen (76, 78, 80) på det ene kamskivelegeme (70, 72, 74);

et tanddrev (48) monteret i det centrale rum (152) i huset (14), tanddrevet (48) griber ind i flerheden af tandhjul (20, 22, 24) og kan drejes omkring en tanddrevsakse (52) orienteret parallelt med rotationsakserne (32, 34, 36);

en kop (68) tilstødende til tanddrevet (48), koppen (68) modtager rørelementet (136) ved indsættelse af rørelementet (136) i det centrale rum (152); hvori koppen (68) er bevægelig i forhold til huset (14) langs tanddrevsaksen (52) mellem en første position, hvori koppen (68) griber ind i stopoverfladen (71, 73) og derved forhindrer kontinuerlig rotation af kamskivelegemerne (70, 72, 74), og en anden position, hvori koppen (68) er ude af indgreb med stopoverfladen (71, 73) og derved tillader kontinuerlig rotation af kamskivelegemerne (70, 72, 74).

2. Anordning (10) ifølge krav 1, yderligere omfattende en ribbe (79), der rager ud fra det ene kamskivelegeme (70, 72, 74), ribben (79) er placeret tilstødende til kamskiveoverfladen (76, 78, 80) på det ene kamskivelegeme (70, 72, 74) og strækker sig rundt om en del af det ene kamskivelegeme (70, 72, 74), den første stopoverflade (71) er placeret på en første ende af ribben (79);

kamskiven omfatter fortrinsvis yderligere en anden stopoverflade (73) placeret på en anden ende af ribben (79), den anden stopoverflade (73) rager ud fra kamskivelegemet (70, 72, 74) på tværs af rotationsaksen (32, 34, 36), den anden stopoverflade (73) er placeret tilstødende til diskontinuiteten (86) af kamskiveoverfladen (76, 78, 80) af det ene kamskivelegeme (70, 72, 74) og med afstand til den første stopoverflade (71);
mere fortrinsvis, hvori den første og anden stopoverflade (71, 73) hver har en konkav krumning (81).

3. Anordningen (10) ifølge krav 1, anordningen (10) omfatter yderligere en flerhed af traktionsoverflader (94, 96, 98), hver traktionsoverflade (94, 96, 98) rager omkring en respektive en af kamskivelegemerne (70, 72, 74), hver traktionsoverflade (94, 96, 98) omfatter en flerhed af fremspringene (100), der strækker sig på tværs af en respektive af rotationsakserne (32, 34, 36), hver af traktionsoverfladerne (94, 96, 98) har et mellemrum (102) deri, hvert mellemrum (102) er justeret aksialt med en respektive af diskontinuiteterne (86) af en af kamskiveoverfladerne (76, 78, 80) på hver af kamskivelegemerne (70, 72, 74).

4. Anordningen (10) ifølge krav 1, som yderligere omfatter en flerhed af stopoverfladerne (71, 73), hver af stopoverfladerne (71, 73) er placeret tilstødende til en respektive af diskontinuiteterne (86) af en af kamskiveoverfladerne (76, 78, 80) på hver af kamskivelegemerne (70, 72, 74);
anordningen (10) omfatter yderligere fortrinsvis en flerhed af ribber (79), hver ribbe (79) rager ud fra et af de respektive kamskivelegemer (70, 72, 74), ribberne (79) er placeret tilstødende til kamskiveoverfladerne (76, 78, 80) på hvert

kamskivelegeme (70, 72, 74) og strækker sig rundt om en del af kamskivelegemerne (70, 72, 74), hver stopoverflade (71, 73) er placeret på en ende af hver af ribberne (79).

5. Anordningen (10) ifølge krav 1, hvori den mindst ene traktionsoverflade (94, 96, 98) ligger over en af kamskiveoverfladerne (76, 78, 80); eller

hvori den mindst ene traktionsoverflade (94, 96, 98) er placeret på det ene kamskivelegeme (70, 72, 74) i forhold til kamskiveoverfladen (76, 78, 80), der strækker sig rundt om det ene kamskivelegeme (70, 72, 74); eller
hvori den mindst ene traktionsoverflade (94, 96, 98) har en konstant radius målt omkring og fra rotationsaksen (32, 34, 36) for det ene kamskivelegeme (70, 72, 74).

6. Anordningen (10) ifølge krav 1, hvori kamskiveoverfladen (76, 78, 80) på det ene kamskivelegeme (70, 72, 74) er placeret mellem tandhjulet (20, 22, 24) og den mindst ene traktionsoverflade (94, 96, 98) på det ene kamskivelegeme (70, 72, 74);
fortrinsvis hvori kamskiveoverfladen (76, 78, 80) på det ene kamskivelegeme (70, 72, 74) er placeret tæt på den mindst ene traktionsoverflade (94, 96, 98) på det ene kamskivelegeme (70, 72, 74), eller hvori den mindst ene stopoverflade (71, 73) er placeret mellem kamskiveoverfladen (76, 78, 80) og tandhjulet (20, 22, 24) på det ene kamskivelegeme (70, 72, 74).

7. Anordningen (10) ifølge krav 1, omfattende højst de tre tandhjul (20, 22, 24), hvert tandhjul (20, 22, 24) omfatter et af kamskivelegemerne (70, 72, 74) og kamskiveoverfladerne (76, 78, 80); eller
anordningen (10) omfatter højst to tandhjul (20, 22, 24), hvert tandhjul (20, 22, 24) omfatter et af kamskivelegemerne (70, 72, 74) og kamskiveoverfladerne (76, 78, 80).

8. Anordningen (10) ifølge krav 1, yderligere omfattende:

en første finger, der strækker sig fra et første af kamskivelegemerne (70, 72, 74) i en retning parallel med og forskudt fra en første af rotationsakserne (32, 34, 36), som det første af kamskivelegemerne (70, 72, 74) roterer omkring;
en aktuator (106) monteret bevægeligt på huset (14), aktuatoren (106) kan

bevæges i indgreb med den første finger for at dreje det første af kamskivelegemerne (70, 72, 74) omkring den første af rotationsakserne (32, 34, 36).

9. Anordningen (10) ifølge krav 8, hvori aktuatoren (106) omfatter et håndtag (108) drejeligt monteret på huset (14), håndtaget (108) har en første overflade, der kan komme i indgreb med den første finger for at dreje det første af kamskivelegemerne (70, 72, 74) omkring den første af akserne;
hvori håndtaget (108) fortrinsvis har en anden overflade, der kan komme i indgreb med fingeren for at dreje håndtaget (108) til en klar position ved rotation af det første af kamskivelegemerne (70, 72, 74).

10. Anordningen (10) ifølge krav 8, yderligere omfattende:

en anden finger, der strækker sig fra et andet af kamskivelegemerne (70, 72, 74) i en retning parallel med og forskudt fra en anden af rotationsakserne (32, 34, 36), som det andet af kamskivelegemerne (70, 72, 74) roterer omkring;
et stop (116) monteret bevægeligt på huset (14), stoppet (116) kan bevæges i indgreb med den anden finger for at forhindre rotation af det andet af kamskivelegemerne (70, 72, 74) omkring den anden af rotationsakserne (32, 34, 36); hvori
ved bevægelse af aktuatoren (106) i indgreb med den første finger, kan stoppet (116) yderligere bevæges ud af indgreb med den anden finger for at tillade rotation af det andet af kamskivelegemerne (70, 72, 74);
hvori stoppet (116) fortrinsvis omfatter en krog (118) drejeligt monteret på huset (14), krogen (118) har en spore, der strækker sig derfra og kan komme i indgreb med aktuatoren (106) for at dreje krogen (118) ud af indgreb med den anden finger ved bevægelse af aktuatoren (106).

11. Anordningen (10) ifølge krav 1, yderligere omfattende en spændepatron (12) til at modtage rørelementet (136), spændepatronen (12) kan drejes omkring en spændepatronsakse, spændepatronsaksen er anbragt koaksialt med tanddrevsaksen (52);
fortrinsvis hvori huset (14) er drejeligt og aksialt glidende monteret tilstødende til spændepatronen (12).

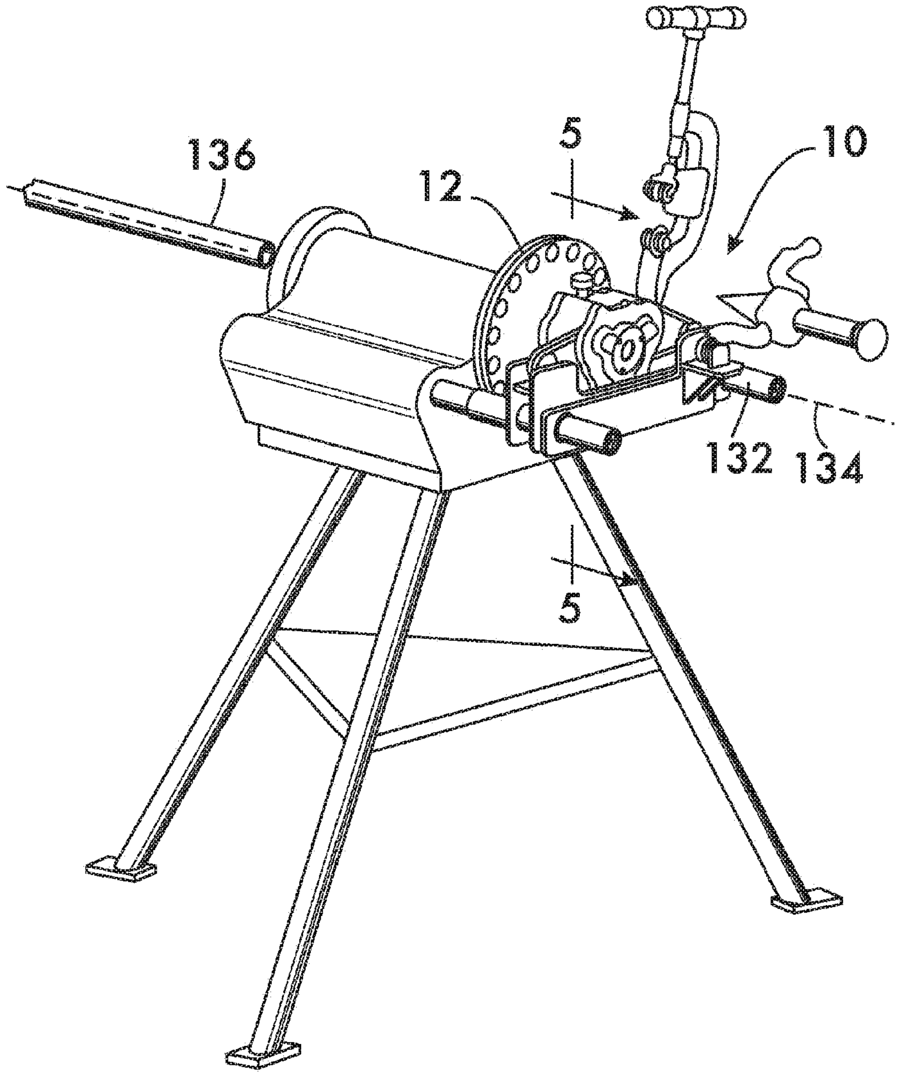
12. Anordningen (10) ifølge krav 1, yderligere omfattende en elektrisk motor (186) i indgreb med tanddrevet (48);

fortrinsvis hvori den elektriske motor (186) er udvalgt fra gruppen bestående af en servomotor og en stepmotor, anordningen (10) yderligere omfatter en styreenhed (188) i forbindelse med den elektriske motor (186) til styring af antallet af omdrejninger af den elektriske motor (186) og derved kamskivelegemerne (70, 72, 74); eller
kamskiven omfatter yderligere fortrinsvis en kobling (192), der virker mellem den elektriske motor (186) og tanddrevet (48) for at styre antallet af omdrejninger af tanddrevet (48) og dermed kamskivelegemerne (70, 72, 74).

13. Anordningen (10) ifølge krav 1, yderligere omfattende et håndsving (204) koblet til tanddrevet (48), håndsvinget (204) er beregnet til manuelt at dreje tanddrevet (48) og dermed tandhjulene (20, 22, 24); hvori håndsvinget (204) fortrinsvis er koblet direkte til tanddrevet (48).

DRAWINGS

FIG. 1



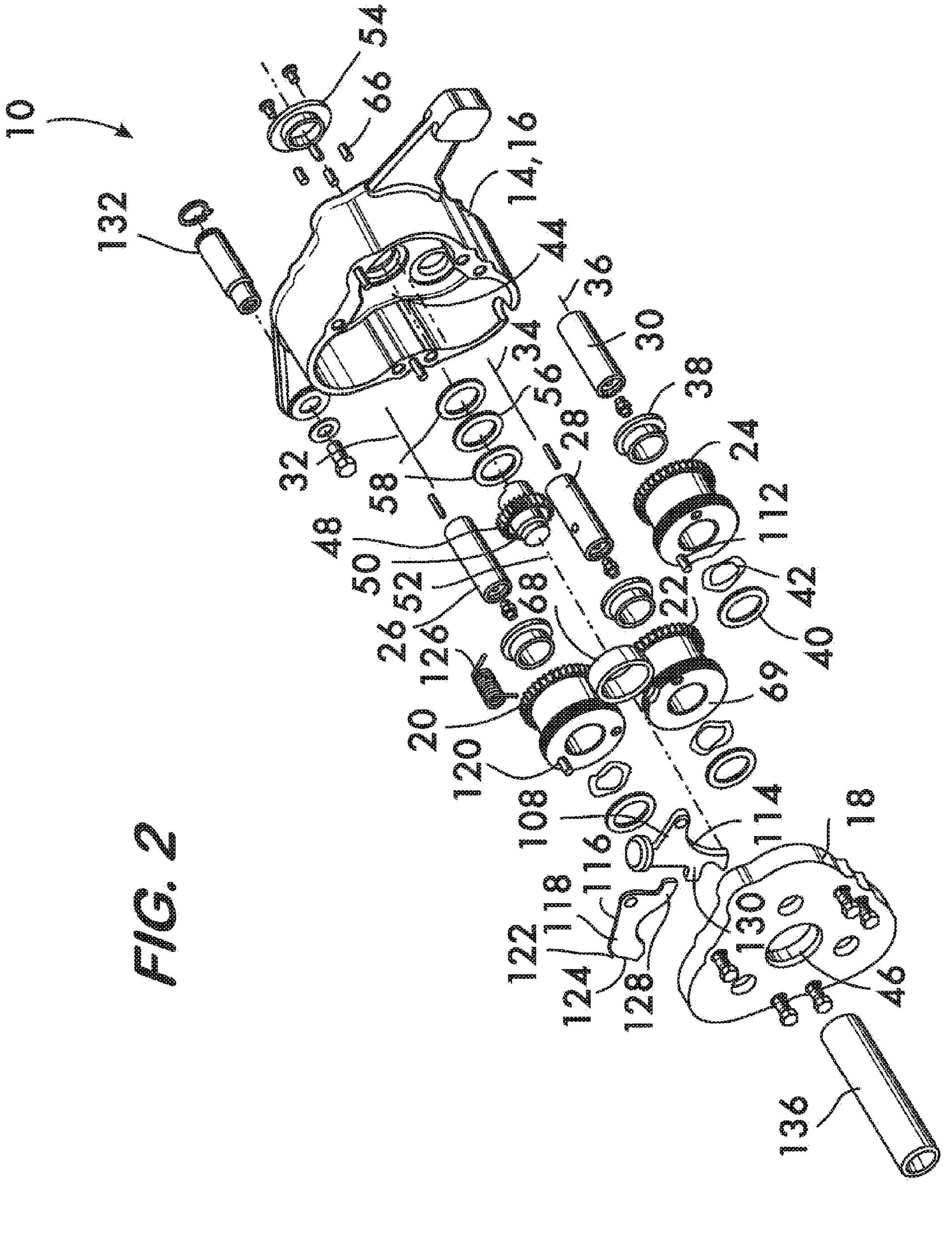

10
132
54
66
14,16
44
36
30
38
34
56
28
32
58
24
112
48
50
52
68
22
42
26
126
40
69
20
120
108
114
116
18
118
122
130
124
128
46
136

FIG. 2

FIG. 3

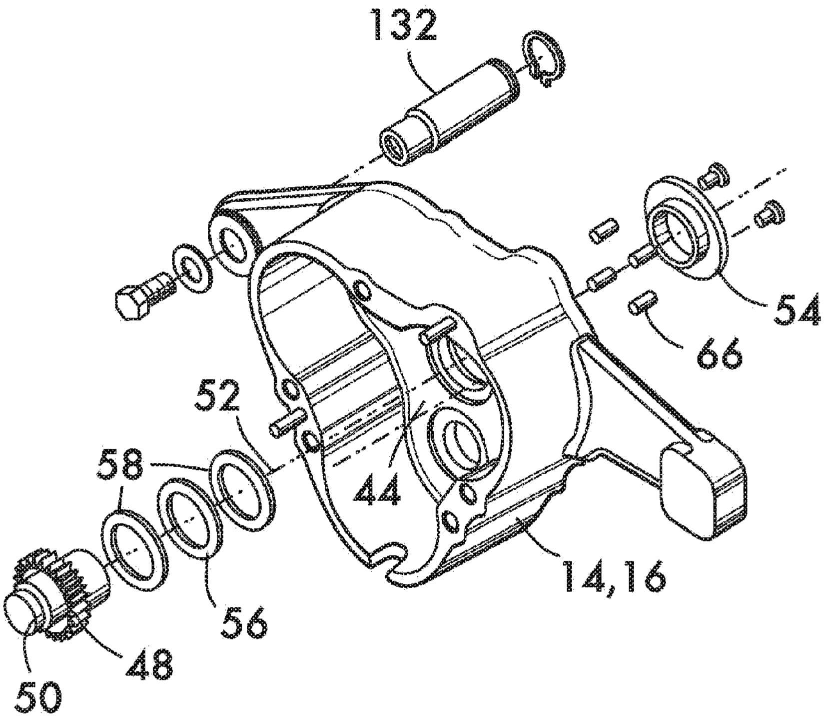


FIG. 3A

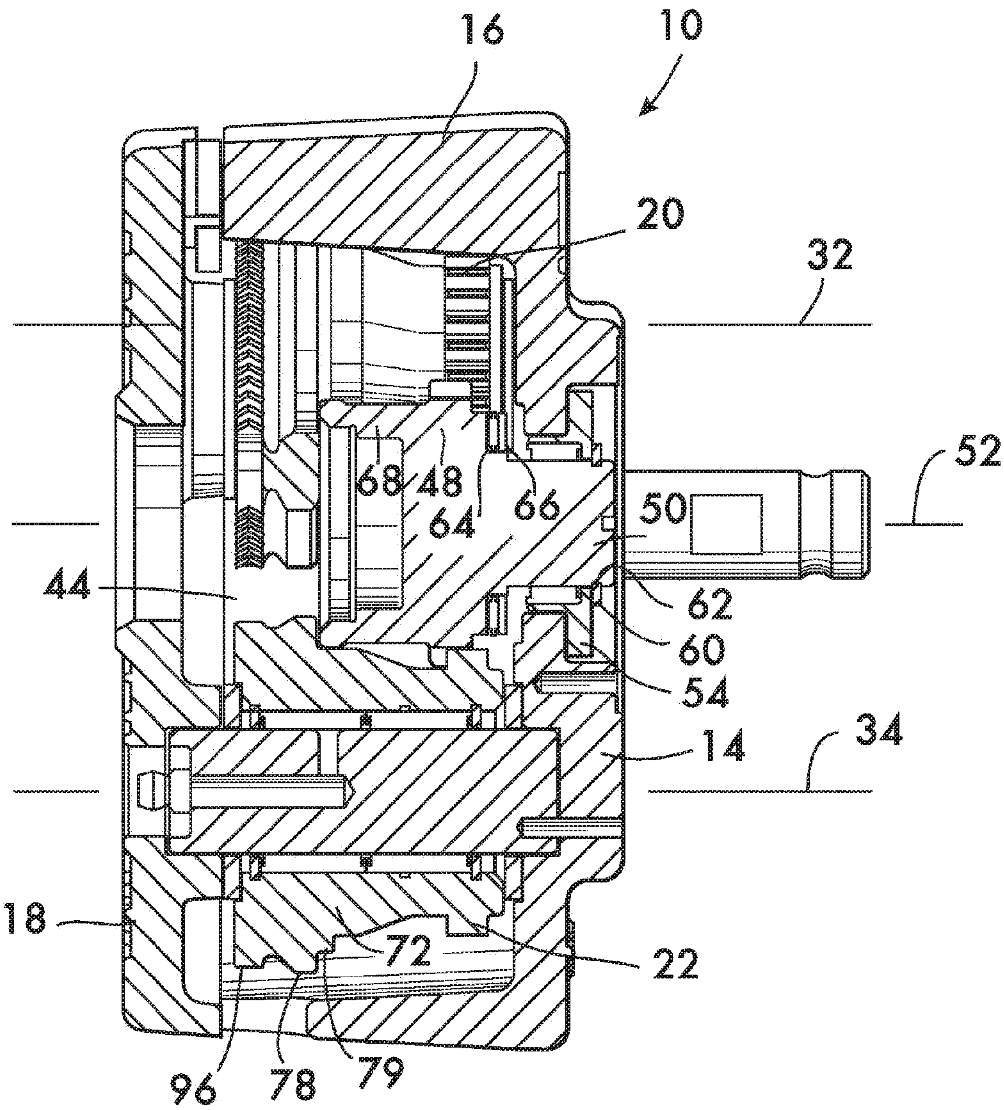


FIG. 4

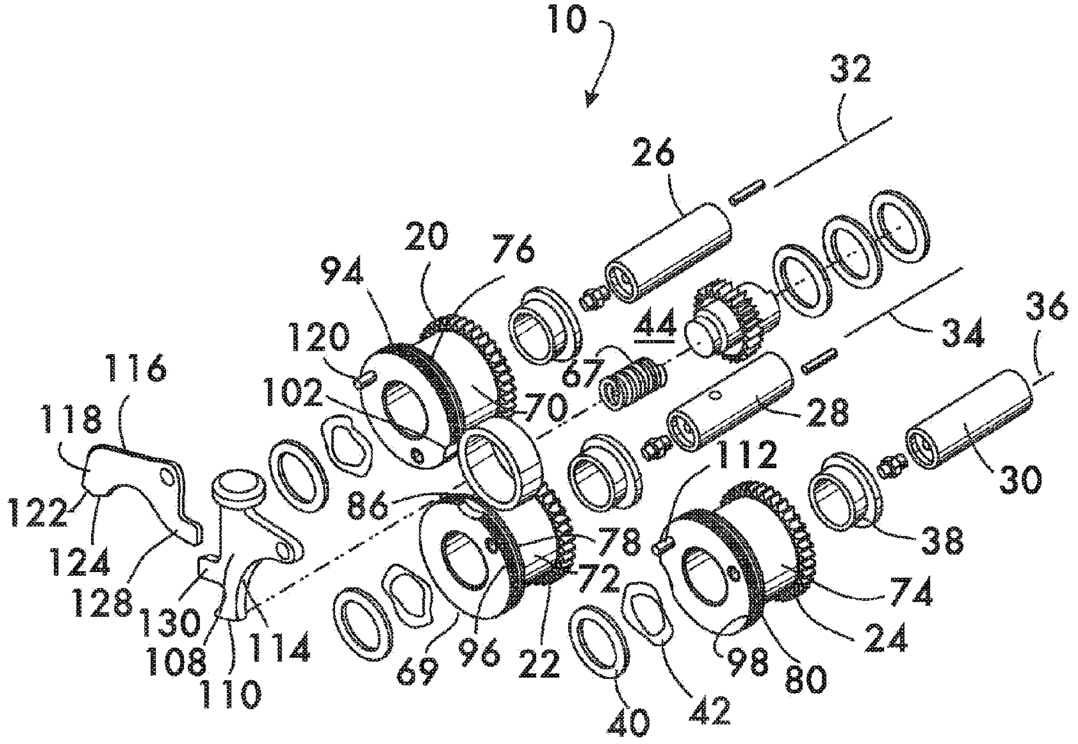

10
32
26
20
76
94
120
116
102
118
122
124
128
130
108
110
114
44
67
70
34
36
28
86
112
30
78
72
74
38
69
96
22
40
42
98
80
24

FIG. 4A

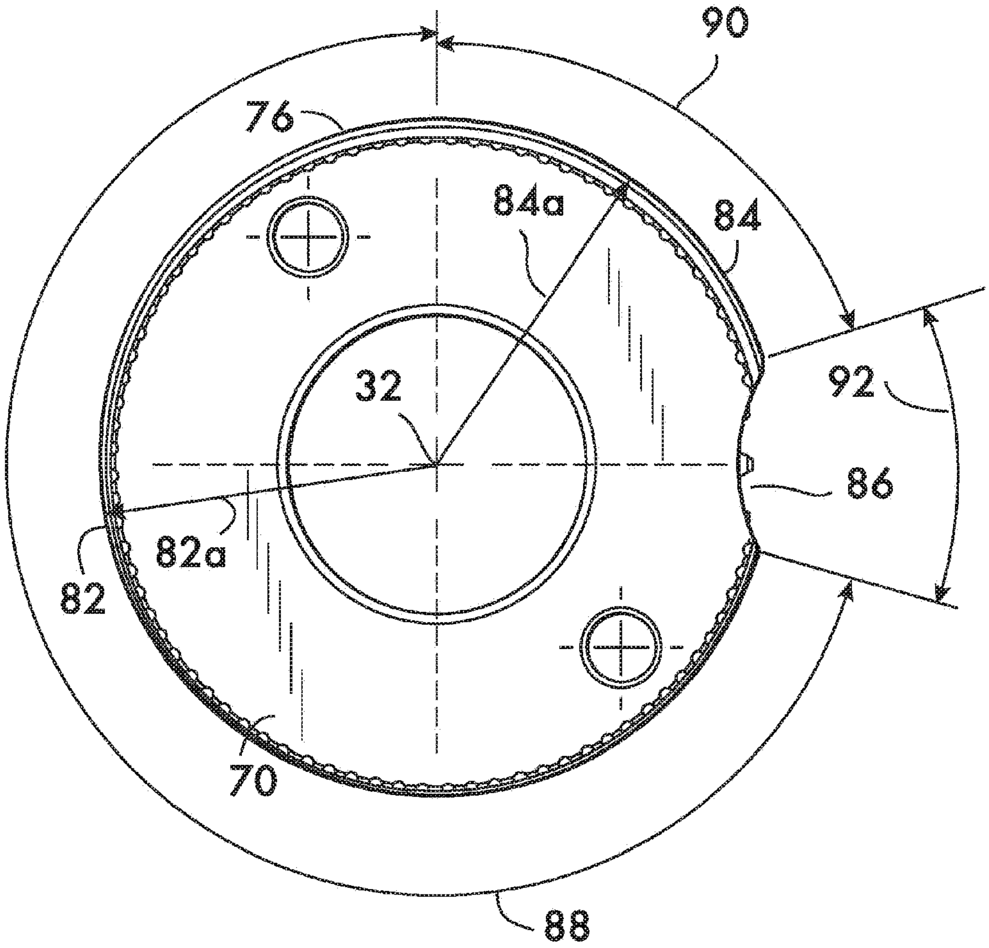


FIG. 4B

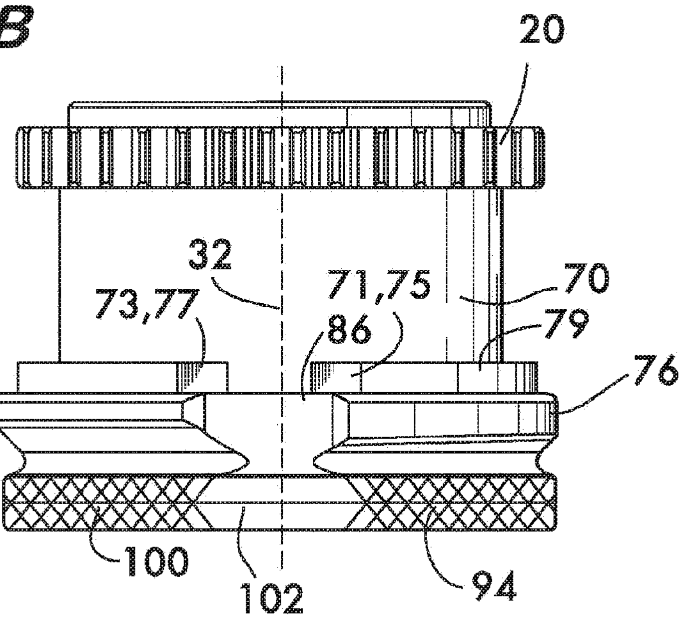

20
32
73,77
71,75
70
86
79
76
100
102
94

FIG. 4D

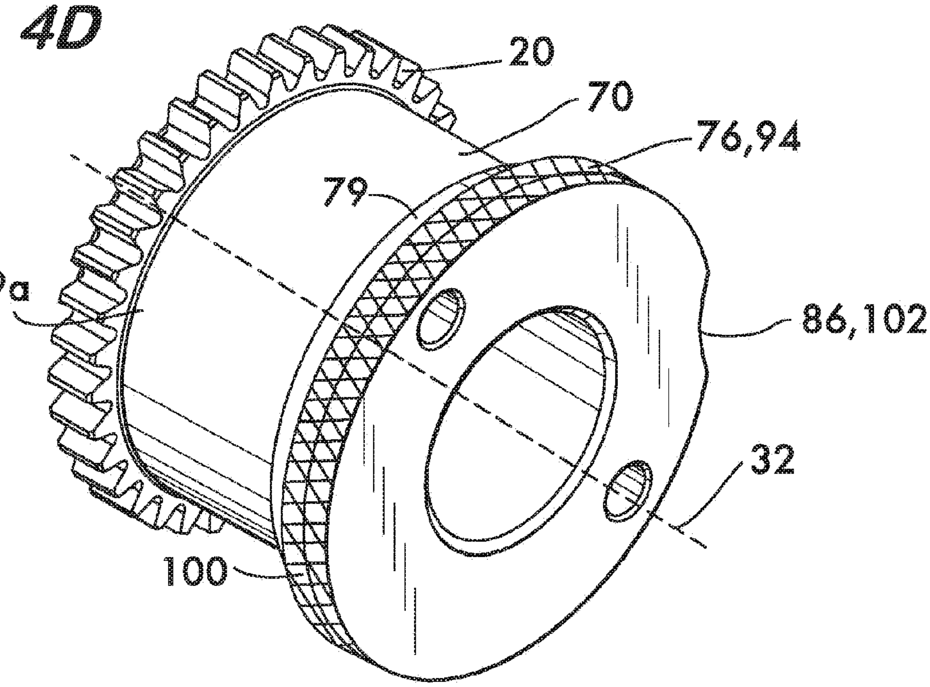

20
70
76,94
79
69a
86,102
32
100

FIG. 4C

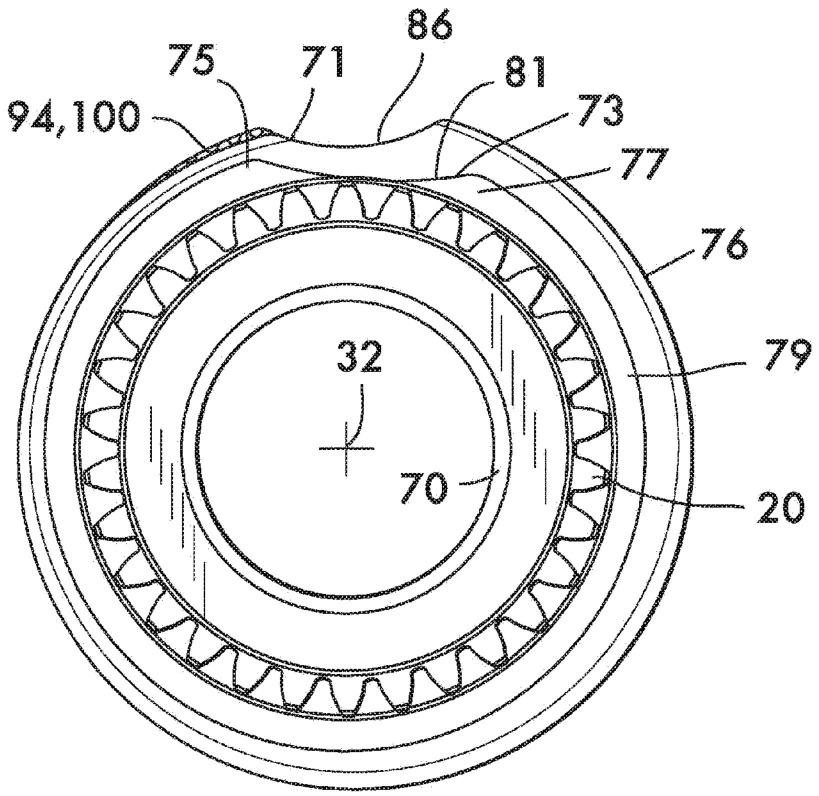


FIG. 5

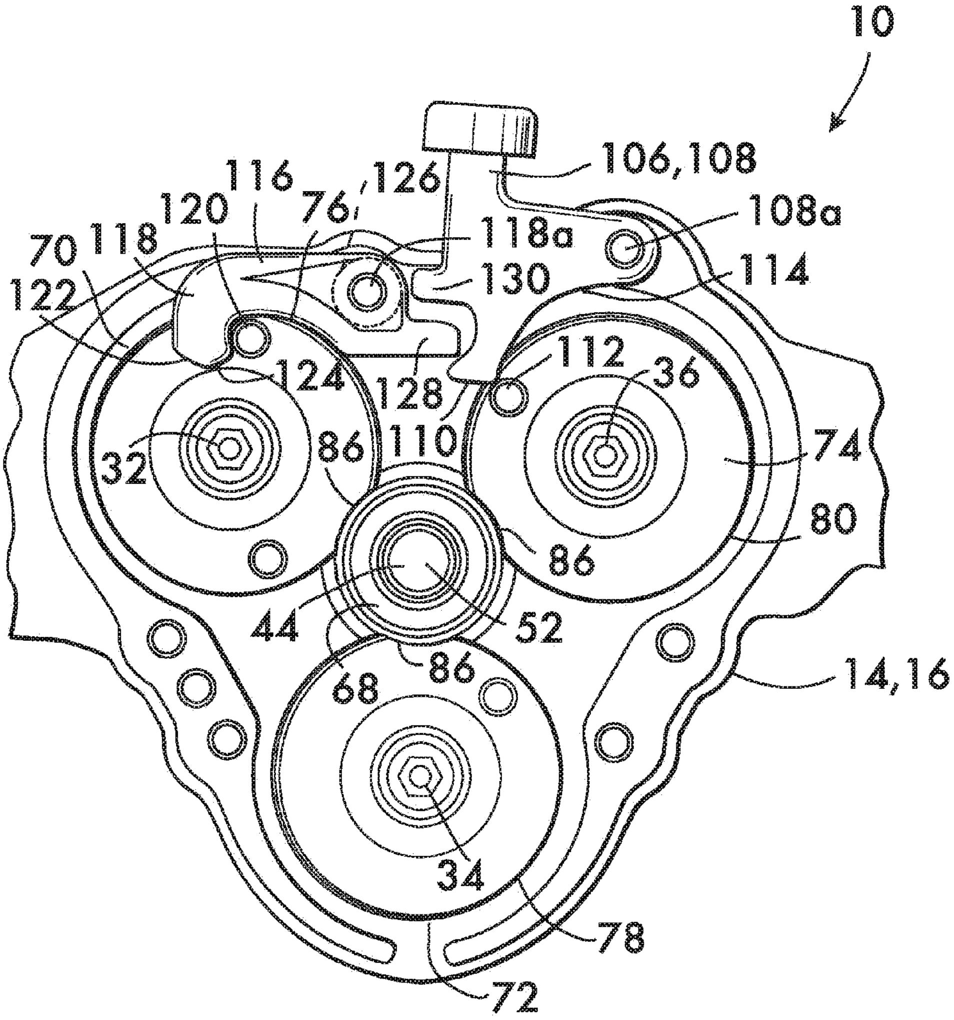

10
106,108
116
,126
120
76
118a
108a
70
118
130
114
122
112
36
124
128
32
86
110
74
80
86
44
52
86
68
14,16
34
78
72

FIG. 6

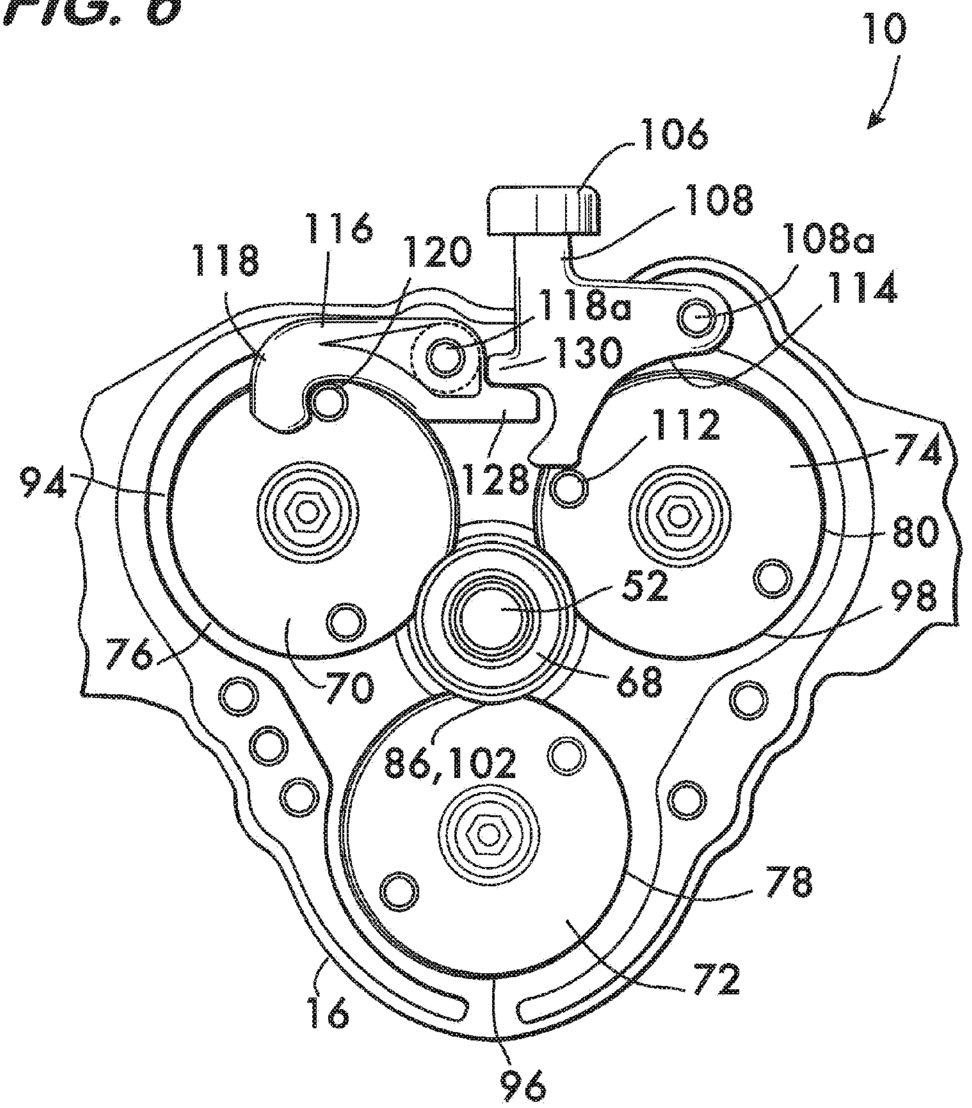

10
106
108
108a
116
120
118
118a
114
130
112
128
74
94
80
52
98
76
70
68
86,102
78
72
16
96

FIG. 6A

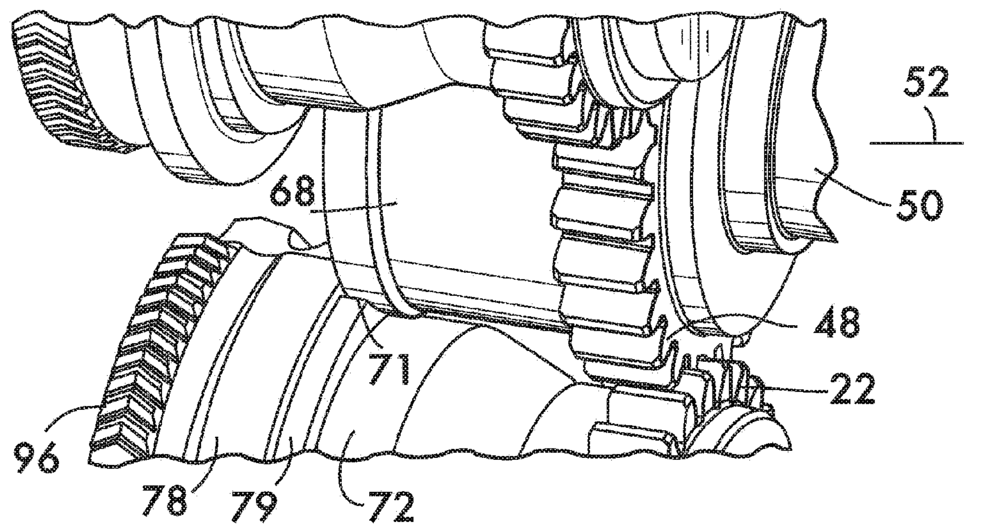


FIG. 6B

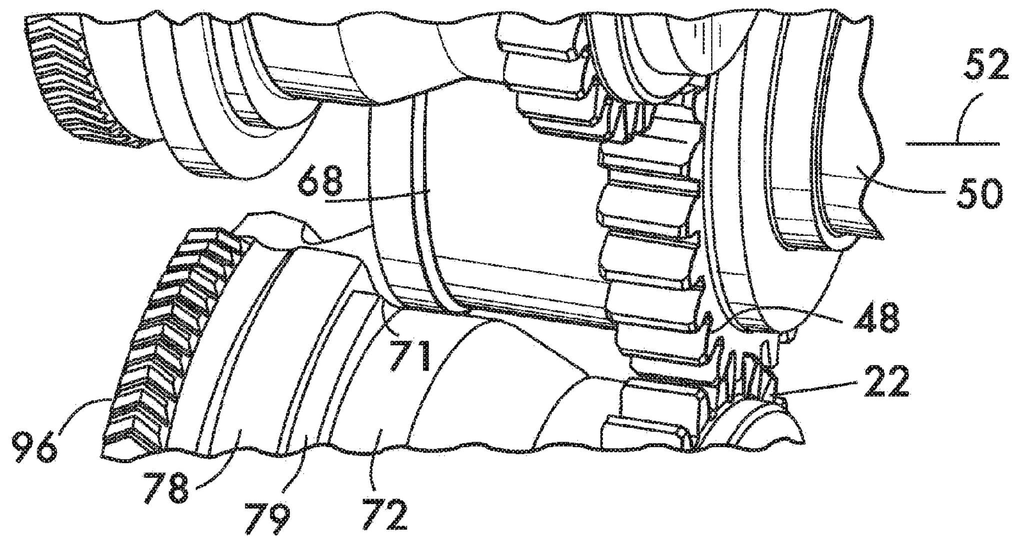


FIG. 7

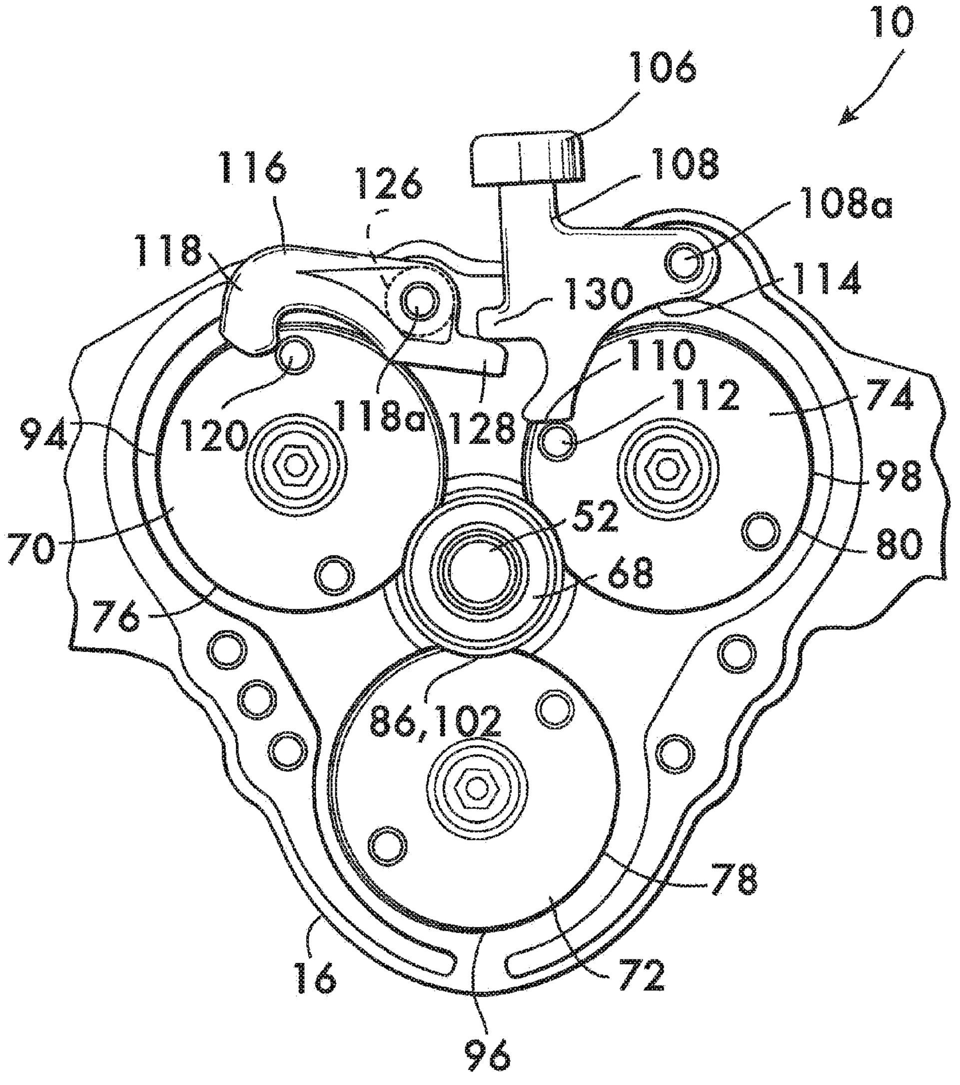

10
106
108
108a
116
126
118
130
114
110
112
74
120
118a
128
94
98
70
52
80
68
76
86,102
78
16
72
96

FIG. 8

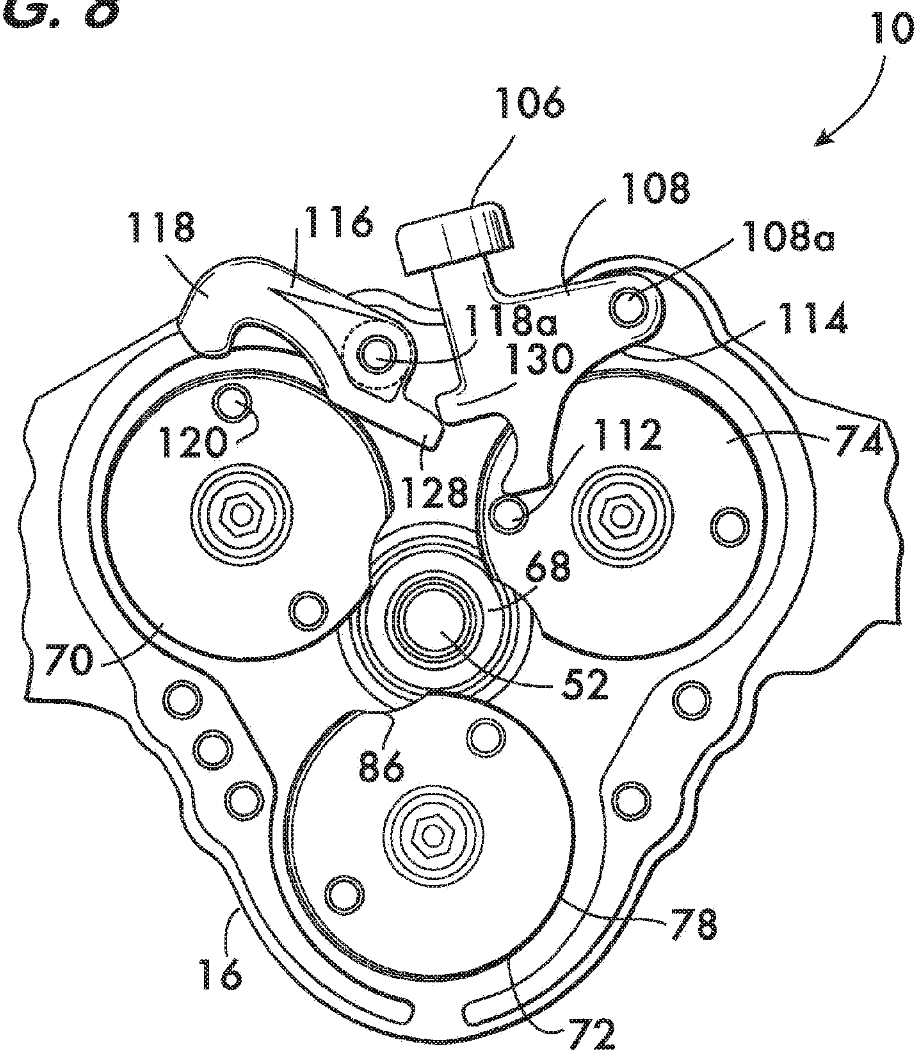

10
106
108
108a
118
116
118a
130
114
120
112
74
128
68
70
52
86
78
16
72

FIG. 9

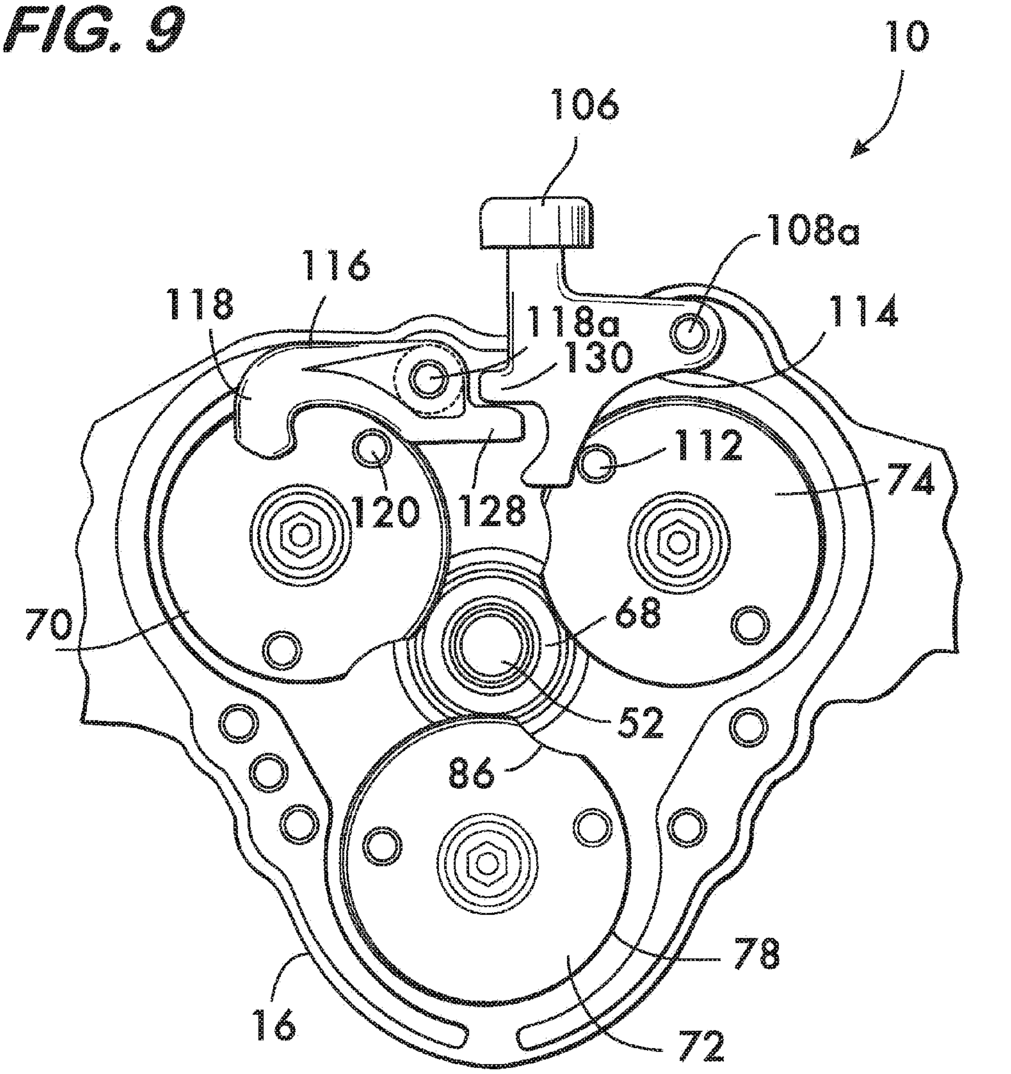

10
106
108a
116
118
118a
114
130
112
120
128
74
70
68
52
86
78
16
72

FIG. 9A

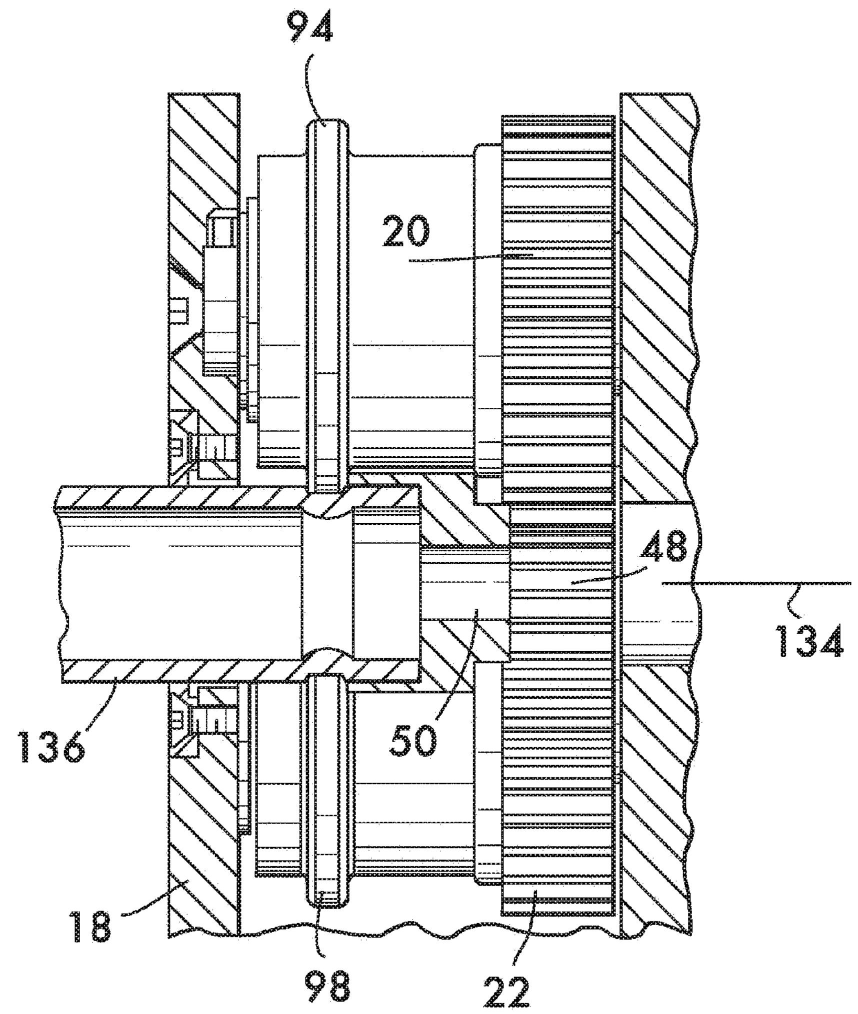


FIG. 10

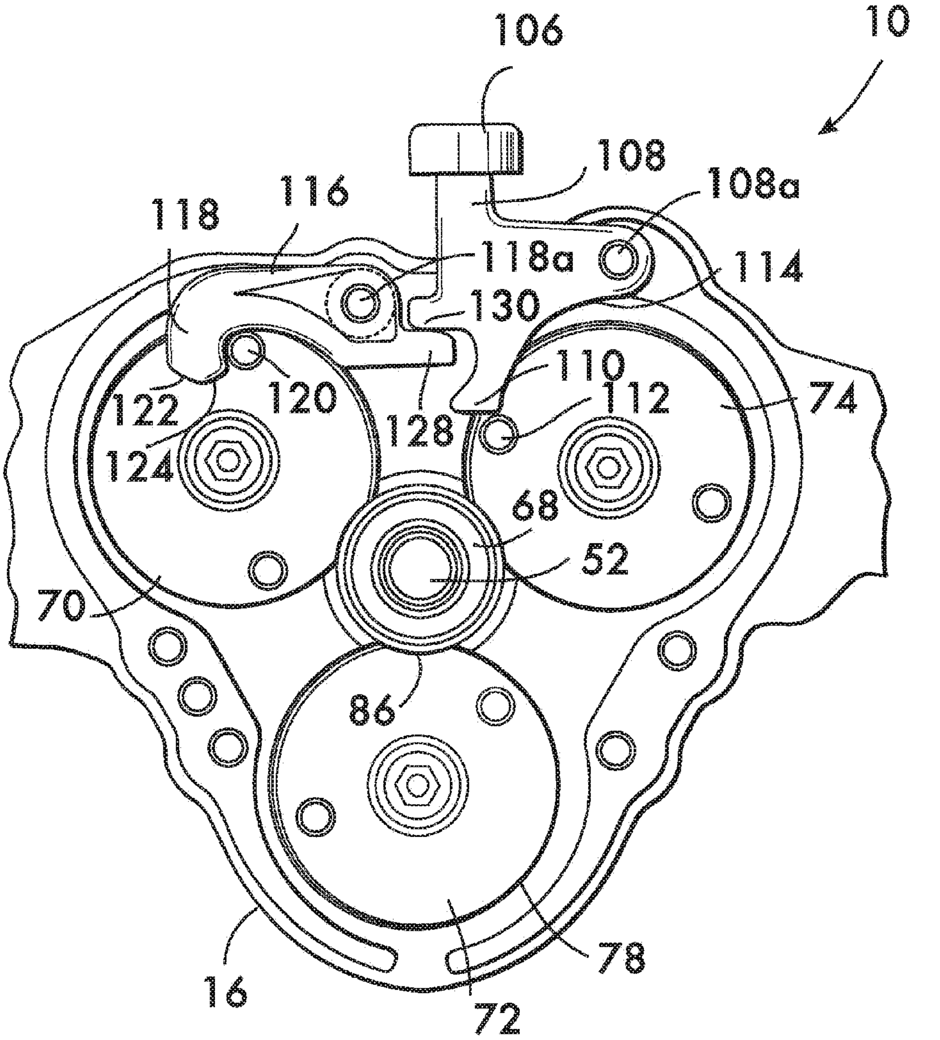

106
10
108
108a
116
118
118a
114
130
110
122
120
128
112
74
124
68
52
70
86
16
78
72

FIG. 11

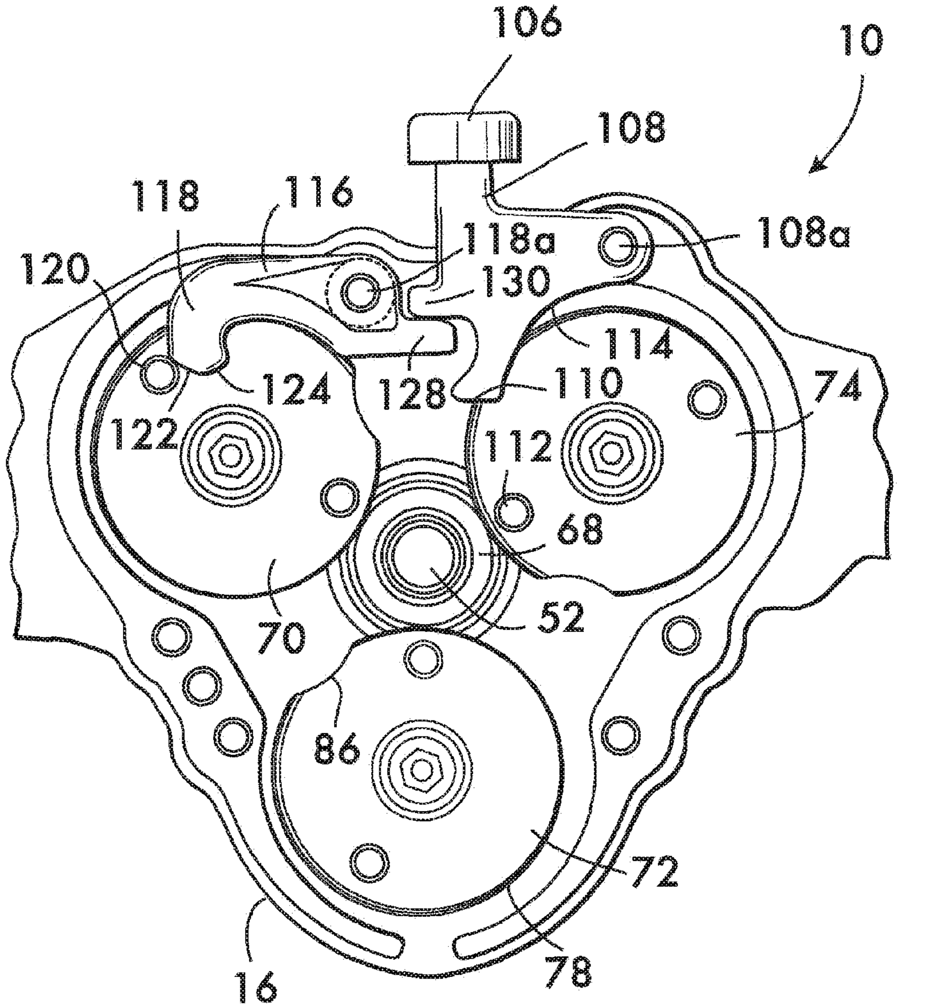

106
10
108
118
116
108a
118a
120
130
114
128
110
124
74
122
112
68
52
70
86
72
16
78

FIG. 12

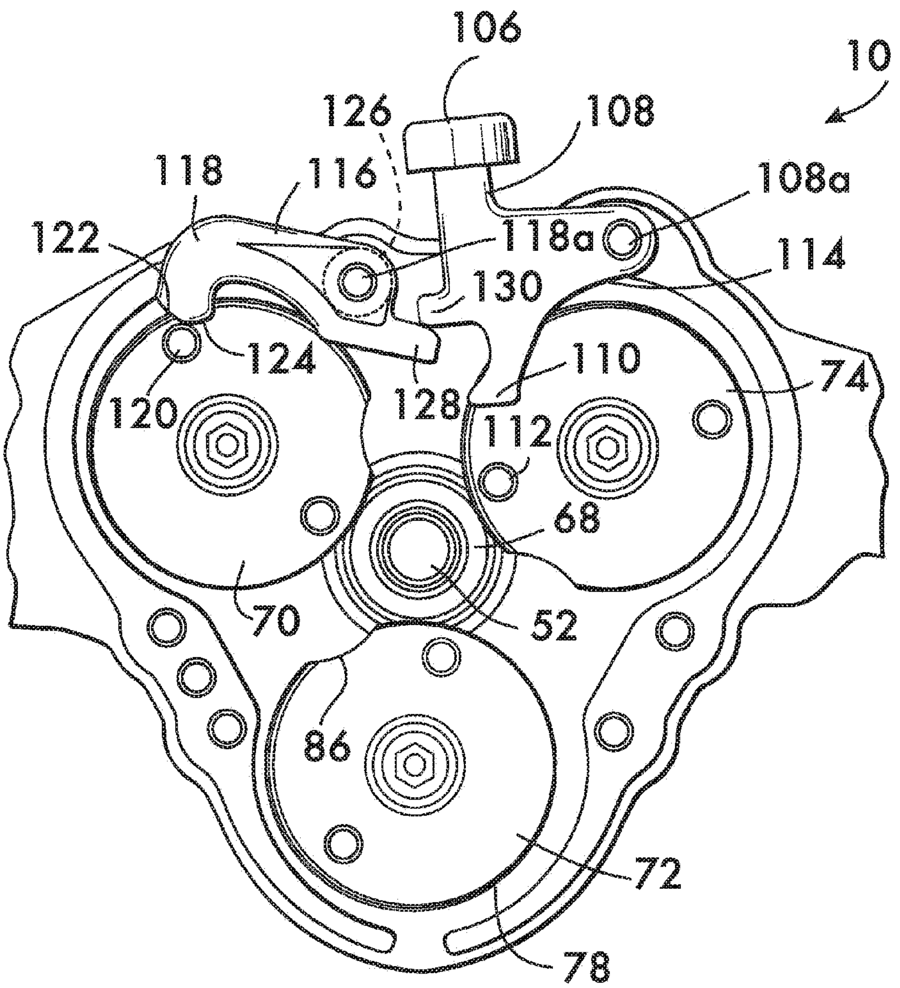

106
10
126
108
118
116
108a
122
118a
114
130
124
110
74
120
128
112
68
70
52
86
72
78

FIG. 13

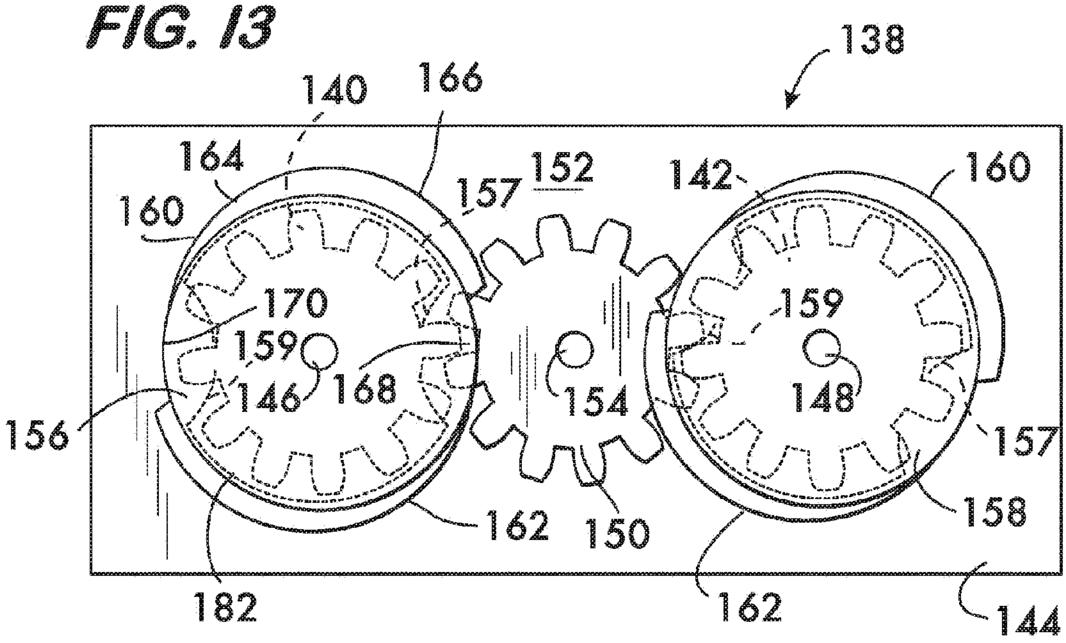

138
140
166
164
152
157
142
160
160
170
159
159
146
168
154
148
156
157
150
158
162
162
182
144

FIG. 14

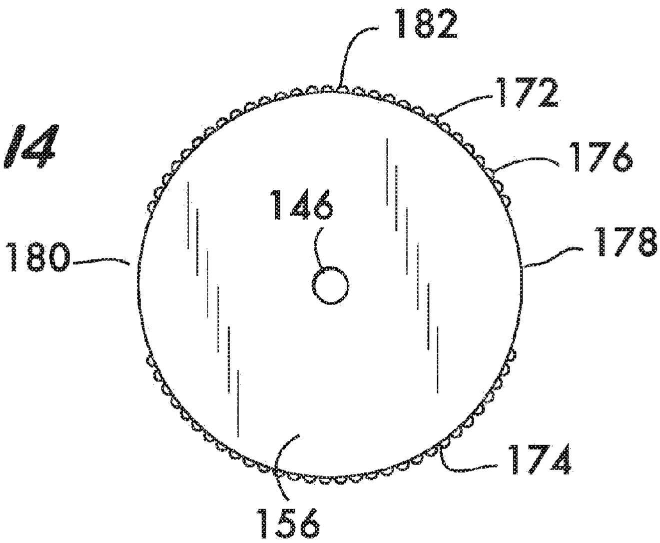

182
172
176
146
180
178
174
156

FIG. 15

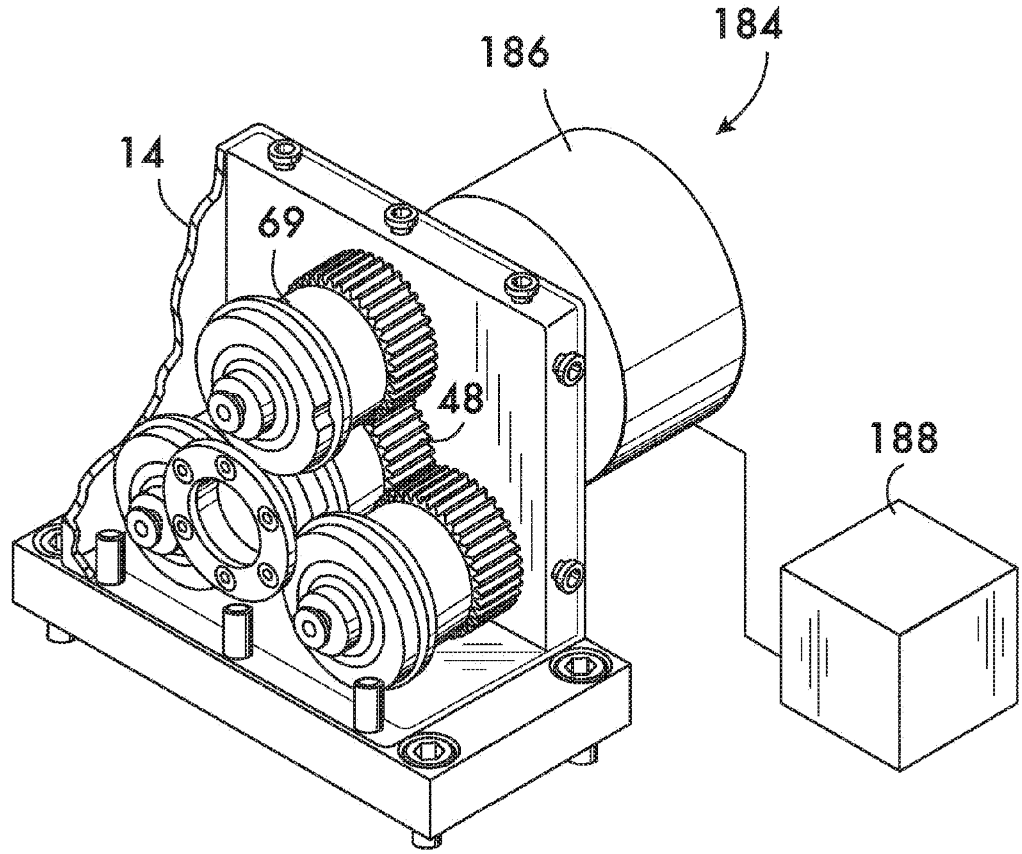


FIG. 16

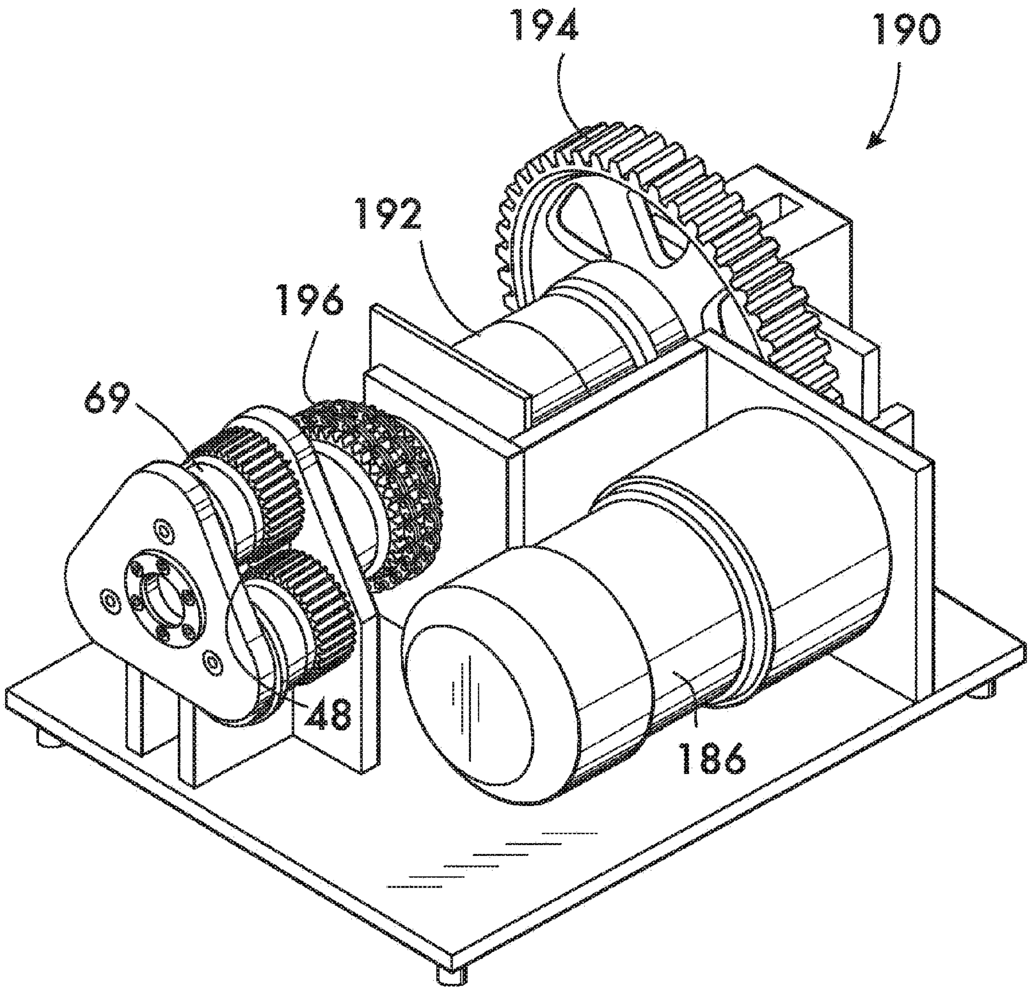


FIG. 17