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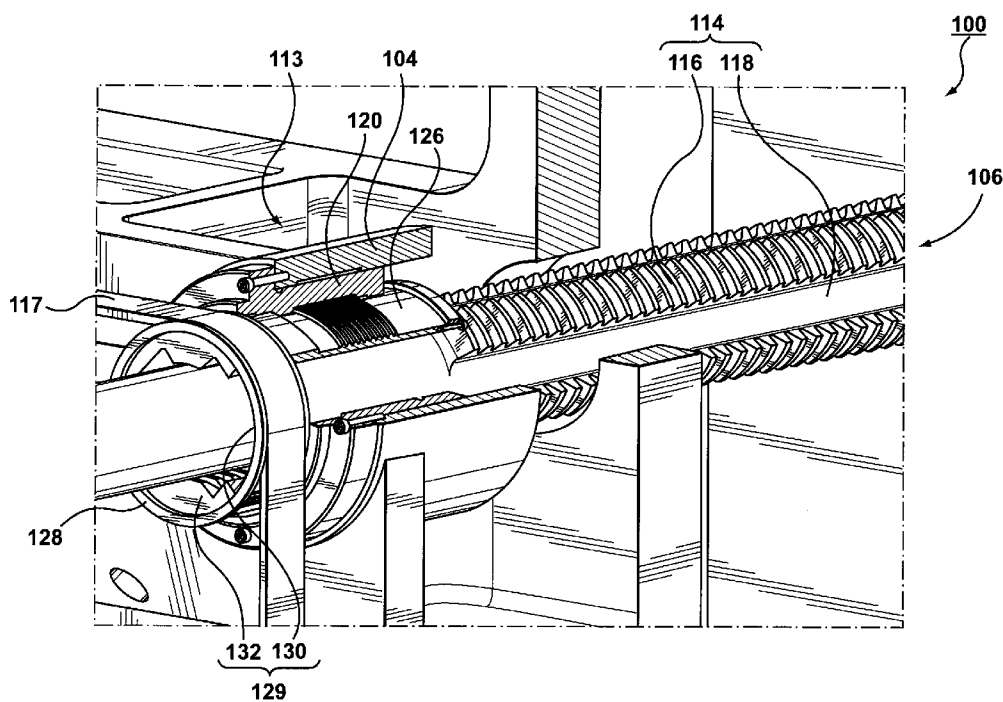
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(54) Title: MOLDING-SYSTEM LOCKING MECHANISM



(57) Abstract: Disclosed is: (i) a molding-system lock, (ii) a molding system having a molding-system lock, and/or (iii) a method of a molding-system lock.

WO 2007/143810 A1

MOLDING-SYSTEM LOCKING MECHANISM**TECHNICAL FIELD**

5 The present invention generally relates to, but is not limited to, molding systems, and more specifically the present invention relates to, but is not limited to, (i) a molding-system lock, (ii) a molding system having a molding-system lock, and/or (iii) a method of a molding-system lock, amongst other things.

BACKGROUND OF THE INVENTION

10 United States Patent Number 5,753,153 (Inventor: Choi; Published: 1998-05-19) discloses a control system for clamp-up and mold-break operations of a tie-bar clamping mechanism. The control system can determine and adjust a starting position of a securing/clamping mechanism and a movable mold
15 after each molding operation to achieve greater accuracy.

United States Patent Number 5,773,050 (Inventor: Wohlrab; Published: 1998-06-30) discloses a tool-closure system for an injection-molding machine that uses a threaded spindle to open and close tools, and piston and cylinder units for applying a high-pressure clamping force.

20 United States Patent Number 5,922,372 (Inventor: Schad; Published: 1999-07-13) discloses a molding-machine platen clamping system that includes columns fixed to a moving platen with teeth at remote end engaged by a hydraulic clamping system (this U.S. patent was reissued on 3 September 2002 as patent USRE 37,827).

25 United States Patent Number 6,186,770 (Inventor: Ziv-Av; Published: 2001-02-13) discloses a clamping assembly for an injection-molding machine that includes a pair of tie bars with threads which engage with threaded bushings in platens by relative rotation of the tie bar and the platens generated by an actuation system.

30 United States Patent Number 6,200,123 (Inventor: Mailliet et al; Published: 2001-03-13) discloses a hydraulic-closure unit, in e.g. a pressure injection-molding machine that combines double-acting annular cylinder with breech-action locking which allows relative sliding of a pressure rod and turns to engage inner and outer threads, taking up play and arriving at a force transmission position.

United States Patent Number 6,210,144 (Inventor: Mailliet et al; Published: 2001-04-03) discloses a closure unit for a pressure injection-molding machines, in compact arrangement which also allows free sliding of a moving platen. The closure unit includes double-acting hydraulic cylinders on a fixed platen which act through locking bushes onto tie rods with interrupted threads which are engaged whilst taking up backlash by turning.

United States Patent Number 6,250,905 (Inventor: Mailliet et al; Published: 2001-06-26) discloses a compact injection-molding machine closure unit that has locking bushes on tie bars between fixed and moving platens which engage with threads on bars to absorb backlash and to transmit a closure force from double-acting hydraulic cylinders.

United States Patent Number 6,439,875 (Inventor: Morita et al; Published: 2002-08-27) discloses a clamping apparatus for an injection-molding machine that includes a mechanical ram and a piston between which a chamber is defined for pressure exertion so as to drive the mechanical ram to obtain a mold-locking force.

United States Patent Number 6,719,553 (Inventor: Hehl; Published: 2004-04-13) discloses a slide-bar or C-frame pressure injection molding machine.

United States Patent Number 6,821,463 (Inventor: Di Dio et al; Published: 2004-11-23) discloses clamping of molds in an injection-molding press by supporting tie rods sliding with respect to platens, providing locking bushes for tie rods, a moving platen, and inter-engaging screw-threaded portions of the tie rods and the locking bushes.

United States Patent Number 6,884,057 (Inventor: Dantlgraber; Published: 2005-04-26) discloses an electro-mechanical tensioning unit that includes two tensioning jaws, a pushing-gear mechanism, and primary and secondary cylinders for moving the tensioning jaws.

United States Patent Number 6,984,121 (Inventor: Fischbach et al; Published: 2006-01-10) discloses a mold-clamping plate for an injection molding machine, that includes a central plate with sleeves at its corners which surround bores for spindles of a spindle drive, and the sleeves are only partially connected to plate.

United States Patent Number 6,971,237 (Inventor: Geiger; Published: 2005-12-06) discloses a servo-actuator for selectively controlling movement of an output member in two directions relative to a

frame in a plastic-molding machine, that includes a motor-driven actuator with hydraulic force amplification.

United States Patent Application Number 2005/0170037 A1 (Inventor: Koike et al; Published: 2005-08-04) discloses a die-clamping unit for an injection-molding machine that has a control device that: (i) drives a half-nut positioning servo-motor with the half-nut and a tie bar engaged with each other by an engaging mechanism and that (ii) controls a hydraulic-die clamping unit.

Prior art molding systems require a clamp piston to actively position interrupted teeth of a tie bar for locking and unlocking the tie bar to a platen, and this arrangement may require additional molding-system cycle time, increased cost and increased complexity of individual control valves for each clamp piston. If stroking of a clamp piston is used for positioning interrupted teeth for locking and unlocking a tie bar to a platen, a volume of hydraulic fluid in a clamp cylinder may be more than required for actual clamping stroke and therefore this arrangement may require more hydraulic fluid flow and energy to compress during a clamp-up phase.

It appears that most prior-art molding systems use at least three separate mechanisms, which are: (i) a lock for locking and unlocking a tie bar with a platen, (ii) a mold shut-height adjustment mechanism to adjust for a mold-shut height position when exchanging one mold for another mold, and/or (iii) a clamp piston that is stroked to accommodate the mold shut-height position within a range of a tooth pitch of interrupted teeth of the tie bar. Disadvantageously, by using each of the separate mechanisms in the prior-art molding systems, the following setbacks may be experienced: (i) increased cost, (ii) increased complexity, (iii) reduced reliability and/or (iv) increased cycle time of the molding system.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a molding-system lock, including a sleeve operatively accommodating locking and unlocking of a platen bar of a molding system, and operatively accommodating mold shut-height adjustment of the platen bar.

According to a second aspect of the present invention, there is provided a molding system, having a molding-system lock, including a sleeve operatively accommodating locking and unlocking of a platen bar, and operatively accommodating mold shut-height adjustment of the platen bar.

According to a third aspect of the present invention, there is provided a method of a molding system, including using a sleeve of a molding-system lock to operatively accommodate locking and unlocking

of a platen bar, and using the sleeve of the molding-system lock to operatively accommodate mold shut-height adjustment of the platen bar.

A technical effect, amongst other technical effects, of the aspects of the present invention is that a molding-system lock includes structure that accommodates cost reduction and improved reliability of a molding system.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the exemplary embodiments of the present invention (including alternatives and/or variations thereof) may be obtained with reference to the detailed description of the exemplary embodiments along with the following drawings, in which:

FIG. 1 is a perspective view of a molding system having a molding-system lock according to a first exemplary embodiment (which is the preferred embodiment);

FIG. 2 is a perspective view of a movable platen of the molding system of FIG. 1;

FIG. 3 is a partial sectional view of the molding system 100 of FIG. 1;

FIG. 4 is a perspective view of the molding-system lock of FIG. 1;

FIG. 5 is a cross-sectional view through a tie bar of the molding system of FIG. 4;

FIG. 6 is another perspective view of the lock of FIG. 1;

FIG. 7 is a cross-sectional view through a tie bar of the molding system 100 of FIG. 6;

FIG. 8 is yet another perspective view of the lock of FIG. 1;

FIGS. 9, 10, 11, 12, 13, 14, and 15 are cross-sectional views through a tie bar of the molding system of FIG. 8;

FIGS. 16 and 17 are cross-sectional views of a molding system having a molding-system lock according to a second exemplary embodiment; and

FIG. 18 is a cross-sectional view of a molding system having a molding-system lock according to a third exemplary embodiment.

The drawings are not necessarily to scale and are sometimes illustrated by phantom lines, diagrammatic representations and fragmentary views. In certain instances, details that are not necessary for an understanding of the embodiments or that render other details difficult to perceive may have been omitted.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

FIG. 1 is a perspective view of a molding system 100 (hereafter referred to as “the system 100”) having a molding-system lock 113 (hereafter referred to as “the lock 113”) according to the first exemplary embodiment. The lock 113 may be also called a molding-system locking mechanism. To accommodate a general overview of the system 100, the lock 113 is not depicted in FIG. 1; however, the lock 113 is depicted (at least in part) and described beginning with reference to FIG. 2.

The system 100 is used to manufacture molded articles (not depicted) such as: (i) a completed article that requires no further processing, and/or (ii) a preform that requires further processing. Examples of the system 100 are: (i) the HyPETTM System, (ii) the QuadlocTM System, (iii) the HylectricTM System, and (iv) the Magnesium-Molding System, all manufactured by Husky Injection Molding Systems Limited (Location: Bolton, Ontario, Canada; WWW-URL: www.husky.ca). The system 100 includes a stationary platen 102, and also includes a movable platen 104 that is movable relative to the stationary platen 102. The stationary platen 102 is adapted to have a mold portion mountable thereto, and the movable platen 104 is adapted to have another mold portion mountable thereto. The mold portions form a mold. An injection unit (not depicted) is also included in the system 100. The mold portions and the injection unit are depicted in FIG. 5.

Tie bars 106 (generally the tie bars 106 are also referred to as the “platen bars 106”) extend from the stationary platen 102 to the movable platen 104. Clamping mechanisms 108 are located in the stationary platen 102, and they are used to actuatably apply a clamping force to the tie bars 106 so that the clamping force is transferable to the platens 102, 104 to hold the mold closed during injection of a molding material into the mold via the injection unit. The clamp mechanisms 108 are threaded (that is, fixedly attached) onto the end of the tiebar 106. After the clamping mechanisms 108 are de-actuated so as to remove the clamping force, a stroke actuator 110 is used to actuatably move the platen 104 away from the platen 102 so that the mold may be opened so as to allow extraction of a molded part from the mold. A mold-break actuator (not depicted) is used to actuatably apply a mold-break force to the mold portions. The stroke actuator 110 and the mold-break actuator may be combined into a single unit if required.

Each of the clamping mechanisms 108 includes: (i) a clamp cylinder 140, and (ii) a clamp piston 142 positionable in the clamp cylinder 140. The clamp cylinder 140 is formed (or is housed) in the stationary platen 102. The clamp piston 142 is connected to a corresponding tie bar 106. The clamp piston 142 is placable in a hard stop position (that is, the clamp piston 142 is abutable against the platen 102). An actuator 197 (piston, etc) is used to push the clamp piston 142 back into its hard stop position (the hard stop position of the clamp piston 142 is not depicted in FIG. 1 to provide an improved view of the clamp 108). The tie bars 106 and their respective clamp pistons 142 are

movable axially toward the stationary platen 102 (that is, to the right of FIG. 1) once hydraulic fluid is introduced into the clamp cylinders. The tie bars 106 and respective clamp pistons are movable toward the movable platen 104 (to the left) by some other means such as hydraulic fluid, springs, etc.

5 FIG. 2 is a perspective view of the movable platen 104 of the system 100 of FIG. 1. In this view, only one tie bar 106 is depicted. Each of the tie bars 106 of FIG. 1 is constructed along a similar fashion to that of the tie bar 106 depicted in FIG. 2. A distal end 112 of tie bar 106 includes bar-interrupted teeth 114 extending over a length of the tie bar 106. The bar-interrupted teeth 114 include: (i) at least one or more rows of tie-bar teeth 116 extending from the tie bar 106, and (ii) at least one or more tie-bar
10 slots 118 defined through the teeth 116 extending longitudinally along the tie bar 106. Preferably, the number of teeth 116 and slots 118 are four; however, any suitable number may be used.

Optionally, an ejector plate 199 is operatively couplable to the movable platen 104, and the ejector plate 199 is used, as known to those skilled in the art, to eject molded parts.

15 The lock 113 (one per tie bar) is adapted to receive a respective tie bar 106. The lock 113 is used to selectively lockably engage and lockably disengage the tie bars 106 with the movable platen 104. The lock 113 includes a sleeve 126 that operatively accommodates locking and unlocking of a tie bar 106 relative to the platen 104. The sleeve 126 operatively accommodates mold shut-height adjustment of
20 the tie bar 106. A lock-drive assembly 115 is used to synchronously lock and unlock the locks 113. Preferably, the lock-drive assembly 115 includes a toothed belt 117 that is drivable by an electric motor 119. According to an alternative (not depicted) of the lock-drive assembly 115, the lock-drive assembly 115 includes hydraulically-driven links that impart motion to the lock 113 so as to lock and unlock the tie bar 106 to the movable platen 104.

25 FIG. 3 is a partial sectional view of the movable platen 104 and the tie bar 106 both of the system 100 of FIG. 1. A fixed sleeve 120 is rigidly attachable to the movable platen 104 so that a clamping force may be transmitted to the movable platen 104 via the tie bar 106. The fixed sleeve 120 includes fixed-sleeve threads 122 extending toward the sleeve 126. The sleeve 126 is threadably engagable
30 (preferably, rotatably engagable) with the fixed sleeve 120. According to a variant, the fixed sleeve 120 is not used and the sleeve 126 is threadably engagable with the platen 104. The purpose of the fixed sleeve 120 is to merely afford ease of manufacturing of the platen 104, and to permit the sleeve 126 to be threadably movable relative to the platen 104 (so that the sleeve 126 can operatively accommodate mold shut-height adjustment of the tie bar 104 and the platen 104).

The sleeve 126 includes externally-extending sleeve threads 124 that are engagable with the fixed-sleeve threads 122. The sleeve 126 includes a tie-bar facing surface (hidden in FIG. 3). The tie-bar facing surface of the sleeve 126 includes sleeve-interrupted teeth 129 (depicted in FIG. 4) that are interlockable with the bar-interrupted teeth 114 of the tie bar 106. The sleeve-interrupted teeth 129 include sleeve-teeth 130 and sleeve slot 132 (the slot 132 extend through the sleeve teeth 130) which are selectively engagable and disengagable with respective tie-bar slots 118 and tie-bar teeth 116 (this arrangement is more clearly shown in FIG. 4). A distal end of the sleeve 126 includes a pulley 128 that is drivable by the belt 117 (that is preferably toothed), and the belt 117 is drivable by the electric motor 119 (depicted in FIG. 2). Preferably, a sufficient length of the sleeve threads 124 and of the fixed-sleeve threads 122 are provided such that the sleeve 126 is rotationally positionable over a length that is greater than a pitch of the sleeve-interrupted teeth 129 of the sleeve 126.

A sufficient axial-tooth clearance is provided in the sleeve-interrupted teeth 129 and the bar-interrupted teeth 114, such that when: (i) the sleeve 126 is rotated between a locked position and an unlocked position and (ii) the tie bar 106 is in a correct position relative to the sleeve 126, a small amount of axial movement between the sleeve threads 124 and the fixed-sleeve threads 122 does not result in contact between the sleeve 126 and the tie bar 106.

FIG. 4 is a perspective view of the lock 113 of the system 100 of FIG. 1, in which the lock 113 is depicted in an unlocked condition. The sleeve 126 is depicted in a position so that the teeth 129 are clear of the teeth 114 so as to allow the sleeve 126 to freely rotate without risk of the two sets of teeth 114, 129 of making contact. This is the sleeve-adjustment position or a lock-clearance position. A set of sleeve teeth 130 and a set of sleeve slot 132 are selectively engagable and disengagable with respective tie-bar slots 118 and tie-bar teeth 116. In the unlocked condition, the sleeve teeth 130 are aligned with the tie-bar slot 118, and the sleeve slot 132 are aligned with the tie-bar teeth 116. The movable platen 104 is depicted positioned such that the mold halves attached to the platens 102, 104 are separated (opened) from each other (this is a mold-open position). In the mold-open position, the movable platen 104 is positioned (usually) furthest away from the stationary platen 102.

FIG. 5 is a cross-sectional view through the tie bar 106 of the system 100 of FIG. 4. A mold includes a mold portion 194 that is fixedly attached to the platen 104. The mold also includes a mold portion 192 that is fixedly attached to the platen 102. In this view, only one tie bar 106 is depicted for simplifying the understanding of the first exemplary embodiment. The clamp mechanism 108 includes the clamp piston 142 and the clamp cylinder 140. In the mold-open position, the tie bar 106 and a clamp piston 142 are positioned to the left side of the stationary platen 102 (that is, they are fully retracted). The belt 117 (not depicted) will be used to rotate each sleeve 126 into a position such

that the sleeve teeth 130 may become lockably aligned (in a lock-registration position) with the tie-bar slots 118 after the platen 104 is stroked to close the mold 192, 194 shut; after the mold is closed and since the teeth 114, 129 are in lockable registration (lock-registration), the sleeve 126 may be further rotated (via the motor and belt 117) sufficiently enough so that the teeth 129 and the teeth 114 may become locked together (a condition depicted in FIG. 9). In FIG. 5, the teeth 114, 129 are depicted as being in a lock clearance position so that the platen 104 and the sleeve 126 may then be stroked so as to then close the mold 192, 194. The injection unit 190 is coupled to the platen 102 so as to inject a molding material into the mold 192, 194.

The sleeve-interrupted teeth 129 are displaced or cleared from the bar-interrupted teeth 114, and this is a lock-clearance condition (that is, the teeth 114, 129 are rotated to clear from each other and then they are longitudinally spaced apart or longitudinally offset from each other so as to permit the sleeve 126 to be rotated by the belt 117 as many times as required). In the lock-clearance condition, the sleeve-interrupted teeth 129 and the bar-interrupted teeth 114 cannot become inter-locked if the sleeve 126 is rotated by the belt 117. Once the sleeve-interrupted teeth 129 are displaced from the bar-interrupted teeth 114, the sleeve 126 may be rotated (moved, placed or positioned) in a lockable-registration position relative to bar-interrupted teeth 114 (that is, lockable registration of the teeth 114, 129 means that the sleeve 126 is so positioned rotated or indexed by the belt 117 so that the teeth 114, 129 are lockable with each other after or once the sleeve-interrupted teeth 129 of the sleeve 126 are moved to overlap the bar-interrupted teeth 114). Placement of the sleeve-interrupted teeth 129 in the lockable-registration position takes into account mold replacement (that is, so that mold-shut height may be accommodated when the mold is closed).

To reach the lock-clearance condition, the sleeve-interrupted teeth 129 were previously moved away from a lockable-engagement condition with the bar-interrupted teeth 114 to the lock-clearance condition.

After placement of the sleeve-interrupted teeth 129 (which takes into account mold replacement), the sleeve-interrupted teeth 129 will be moved from the lock-clearance condition to a lockable-engagement condition (the lockable-engagement condition is depicted in FIGS. 7 and 9) with the bar-interrupted teeth 114 so that upon mold closure, the sleeve-interrupted teeth 129 and the bar-interrupted teeth 114 are advantageously registered to be interlockable with each other.

A technical effect, amongst other technical effects, of the lock 113 is that since the lock 113 includes structure that: (i) controls mold shut-height adjustment, and (ii) locks and unlocks a tie bar to the platen 104, the advantages of: (i) cost reduction, and/or (ii) improved reliability of the system

may be realized. Another potential technical effect of the lock 113 is that a clamp piston stroke is reduced to a minimum (that is, the stroke may be performed so that only what is required for tooth clearance and for straining molding-system components under a clamp-up condition). Yet another potential technical effect of the lock 113 is that only one valve may be used to control all clamp
5 pistons. Yet another potential technical effect of the lock 113 is that cycle time may be improved because active re-positioning of clamp pistons is not necessarily required for locking or unlocking of a tie bar, and a clamp piston is positionable with a hard stop at the end of its travel.

FIG. 6 is another perspective view of the lock 113 of the system 100 of FIG. 1, in which the lock 113
10 is depicted in the lockable engagement condition but the teeth 114, 229 are unlocked from each other). The teeth 114, 129 may be referred to as “pineapple” structures. After mold installation, the movable platen 104 has been moved or stroked toward the stationary platen 102 (that is, toward the right side of FIG. 6) until the mold is closed (that is, the mold-closed position). The mold-closed position is sensed by a position sensor (not depicted) that is coupled to a control computer (not
15 depicted), and the control computer records the sensed mold-closed position for future reference. After the mold-closed position has been recorded, the movable platen 104 is moved back to the left (that is, to the mold-open position) past the bar-interrupted teeth 114 of the tie bars 106 (as shown in FIG. 4). Each of the sleeves 126 are then rotated by the motor 119 and the belt 117 to a position where the sleeve interrupted teeth 130 and the tie-bar interrupted teeth 116 are clear of each other
20 after the platen 104 is stroked to close the mold.

FIG. 7 is a cross-sectional view through the tie bar 106 of the system 100 of FIG. 6. In this view, only one tie bar 106 is depicted for simplifying the understanding of the first exemplary embodiment. The movable platen 104 is depicted stroked back to the mold-closed position, but the sleeve interrupted
25 teeth 130 and the bar-interrupted teeth 114 are depicted disengaged with each other (that is: they are not yet engaged with each other).

FIG. 8 is yet another perspective view of the lock 113 of the system 100 of FIG. 1, in which the lock 113 is depicted in the lockable engagement condition and the teeth 114, 229 are locked together (that
30 is, inter-locked). Now each of the sleeves 126 is rotated such that the sleeve-interrupted teeth 129 and the bar-interrupted teeth 114 may become engaged with each other.

FIG. 9 is a cross-sectional view through the tie bar 106 of the system 100 of FIG. 8. Each of the sleeves 126 is rotated such that the sleeve-interrupted teeth 129 and the bar-interrupted teeth 114 are
35 engaged with each other. The clamp mechanism 108 is not yet energized.

FIG. 10 is a cross-sectional view through the tie bar 106 of the system 100 of FIG. 8, in which the clamp piston 142 is moved to the right. Notice the oil chamber formed between the clamp piston 142 and the stationary platen 102 as a result of the clamp piston 142 being moved. Now a clamp force is generated and applied to the tie bar 106 so as to transmit the clamping force to the movable platen 104 and to the stationary platen 102. Now a molding material may be injected into the mold. The clamp piston 142 is moved from its hard stop position (that is, away from abutting the platen 102).

FIG. 11 is a cross-sectional view through the tie bar 106 of the system 100 of FIG. 8, in which the clamp piston 142 is decompressed, and then a mold-break force is applied by the actuator 110 so as to open the mold; then the clamping piston 142 is moved fully to the left. By using the actuator 110, cycle time may be reduced. It will be appreciated that the mold-break force may be applied by another device, such as the clamp piston 142 for example.

A reset piston or actuator 197 (see FIG. 1) is used to move the clamping piston 142 fully to the left so that the clamp piston 142 abuts the stationary platen 102. This condition results in a clearance between the tie-bar teeth 116 and the sleeve slot 132. At the bottom right-hand corner of FIG. 1, there is shown a cross-sectional view of the clamp assembly 108, in which the actuator 197 is depicted to the right side of the clamp piston 142, and the actuator 197 is used to stroke the clamp piston 142 to the left. The clamp piston 142 is now located back into its hard stop position (that is, the clamp piston 142 is made to abut the stationary platen 102).

Then the sleeve 126 is rotated such that the sleeve-interrupted teeth 129 are disengaged from the bar-interrupted teeth 114. Then the actuator 110 strokes the movable platen 104 away from the stationary platen 102 so as to separate the mold sufficiently enough to remove a molded part from the mold.

FIGS. 12 and 13 are cross-sectional views of the system 100. The mold portion 194 was replaced by a mold portion 196 (portion 196 is smaller than the portion 194). The mold portion 192 was replaced by a mold portion 198 (the portion 198 is smaller than the portion 192). The sleeve-interrupted teeth 129 are displaced or cleared from the bar-interrupted teeth 114 (this is a lock-clearance condition), so that the sleeve-interrupted teeth 129 may be placable or positioned in a lock-registration position relative to bar-interrupted teeth 114, and placement of the sleeve-interrupted teeth 129 the lock-registration position takes into account mold replacement (that is, so that mold-shut height may be accommodated when the mold is closed).

The sleeve 126 was rotated by the belt 117 so that the sleeve 126 operatively accommodates mold shut-height adjustment of the platen 104 (once the platens 102, 104 are stroked closed). FIG. 13

depicts that after the movable platen 104 is stroked to close the mold portions 196, 198, the sleeve 126 is ready to become lockably engaged with the tie bar 106.

FIGS. 14 and 15 are cross-sectional views of the system 100, in which the teeth 114, 129 have become interlocked so that a clamping force may be applied by the clamp piston 142 to clamp the mold portions 196, 198 shut.

FIGS. 16 and 17 are a cross-sectional views of a molding system 200 (hereafter referred to as “the system 200”) having a molding-system lock 213 (hereafter referred to as “the lock 213”) according to the second exemplary embodiment. These views are taken from above the system 200. The system 200 includes an injection unit 201 that is interactable with a mold 293. To facilitate an understanding of the second exemplary embodiment, elements of the second exemplary embodiment (that are similar to those of the first exemplary embodiment) are identified by reference numerals that use a two-hundred designation rather than a one-hundred designation (as used in the first exemplary embodiment). For example, the lock of the second exemplary embodiment is labeled 213 rather than being labeled 113. Only one tie bar 206 (generally, the tie bar 206 is also called the “platen bar 206”) is depicted for improving the description of the second exemplary embodiment.

According to the second exemplary embodiment, the tie bar 206 is fixedly attached to a movable platen 204 (by way of a nut 205). The stroke actuator 210 is used to stroke the movable platen 204 relative to a fixed platen 202 so as to close the mold 293, which includes a mold portion 294 attached to the movable platen 204, and also includes a mold portion 292 attached to the stationary platen 202. The tie bar 206 includes tie-bar interrupted teeth 214 at the end of the tie bar 206 located proximate to the stationary platen 202. The tie-bar interrupted teeth 214 include rows of teeth 216 and slots (which are not depicted) that are aligned along the rows of teeth 216.

The mechanism 213 includes a sleeve 226. A clamp mechanism 208 is fixedly attached to the stationary platen 202 so as to be interactable with the tie bar 206. A clamp piston 242 is housed in a housing 241. Within the housing 241 is a clamp cylinder 240 that is interactable with the clamp piston 242. The clamp piston 242 is threadably engagable with the sleeve 226; specifically, the clamp piston 242 includes clamp-piston threads 222 that are interactable with sleeve threads 224. The sleeve 226 is interactable with a belt drive (not depicted) in the same way as that of the sleeve 126 of the first exemplary embodiment. The system 200 is shown in a mold open condition, and the interrupted teeth of the sleeve 226 are rotated so as to not interfere with the interrupted teeth 214 of the tie bar 206.

FIG. 17 shows the stroke actuator 210 has stroked the movable platen 204 toward the stationary platen 202 so also to close the mold halves 292, 294 together. The sleeve 216 has been rotated by use of the belt drive so that the sleeve interrupted teeth 229 are now engaged with the tie-bar interrupted teeth 214. The clamp assembly 208 may now be actuated hydraulically so as to apply a clamping
5 force to the mold 293; after a molded article has been molded, the clamp assembly 208 may then be energized to apply a mold-break force to separate the mold portions 292, 294 apart from each other so that then the stroke actuator 210 may then move the movable platen 204 away from the stationary platen 202 so that the molded part may be removed from the mold 293.

10 It will be appreciated that the sleeve 226 is rotatable so that the sleeve 226 operatively accommodates mold shut-height adjustment of the platen 204 (once the platens 202, 204 are stroked closed). After the movable platen 204 is stroked closed, the sleeve 226 may be lockably engagable with the tie bar 206.

15 FIG. 18 is a cross-sectional view along a longitudinal axis of a molding system 300 (hereafter referred to as "the system 300") having a molding-system lock 313 (hereafter referred to as "the lock 313") according to the third exemplary embodiment. The system 300 includes an injection unit 301 that is interactable with mold portions 392, 394. To facilitate an understanding of the third exemplary embodiment, elements of the third exemplary embodiment (that are similar to those of the first
20 exemplary embodiment) are identified by reference numerals that use a three-hundred designation rather than a one-hundred designation (as used in the first exemplary embodiment). For example, the lock of the third exemplary embodiment is labeled 313 rather than being labeled 113.

The molding system 300 includes a base 303. A stationary platen 302 is fixedly attached to the base
25 303. A movable platen 304 is transversally slidable along the base 304. A stationary mold half 392 is fixedly attached to the stationary platen 302. A movable mold half 394 is fixedly attached to the movable platen 304. The mold halves 392, 394 cooperatively define a mold cavity therebetween for molding an article therein.

30 A clamp assembly 308 is depicted in a mold-opened position is mounted to a clamp platen 305 (sometimes called a clamp block). Generally, a clamp column 306 (which is also called the 'platen bar 306') extends from the clamp platen 305. An actuator 370 is actuatable to translate or stroke the movable platen 304 toward and away from the stationary platen 302 (so as to open and close the mold halves 392, 394 relative to each other).

The actuator 370 includes the clamp column 306 which is attached to the movable platen 304. Once the mold halves 392, 394 are closed against each other, the clamp assembly 308 is actuated to apply a clamping force to the mold halves 392, 394 while an injection unit 301 injects a molding material into the mold cavity (defined by the mold portions 392, 394). The clamping force keeps the mold halves 392, 394 together while the molding material enters the mold cavity under pressure. Once the molding material has solidified in the mold cavity, the clamp assembly 308 removes the clamping force and then it actuates to apply a mold-break force that is used to separate the mold halves 392, 394 apart from each other so that the molded article may then be removed from the mold halves 392, 394. Then once the mold halves 392, 394 are broken apart, the actuator 370 actuates to move (or stroke) the platens 302, 304 apart from each other.

The clamp assembly 308 includes a clamp piston 342. Bar-interrupted teeth 316 extend from the clamp column 306 (that is, the platen bar 306). The bar-interrupted teeth 314 include: (i) at least one or more rows of tie-bar teeth 316 extending from the bar 306, and (ii) at least one or more tie-bar slots 318 (not depicted) defined through the teeth 116 extending longitudinally along the bar 306. The sleeve 326 includes sleeve-interrupted teeth 329 (teeth 329 are not depicted in FIG. 18 because they are positioned to be unlocked from the teeth 314 in this view). The teeth 314, 329 are lockable relative to each other between an unlocked position and a locked position. The actuator 370 (which is sometimes referred to as a "stroke cylinder") is used to: (i) actuatably move the clamp column 306 which then, in turn, moves the movable platen 304 to open (or separate) the mold halves 392, 394, or (ii) actuatably close the mold halves 392, 394 relative to each other. The actuator 370 includes a rod 374 and a cylinder head 375 disposed within a chamber 376 defined by the clamp column 306. Defined by the chamber 376 and the cylinder head 375 are a mold-opened hydraulic column 377 and a mold-closed hydraulic column 378. The actuator 370 is actuated to close the mold halves 392, 394. Preferably, the actuator 370 is slowed down just before the mold halves 392, 394 make contact with each other to ensure that the mold halves 392, 394 do not collide (this is sometimes referred to as a mold-protect phase). A housing 379 houses the clamp piston 342, and the clamp piston 342 moves relative to the housing 379. Sometimes the housing 379 is attached to the clamp platen 305. One way to accommodate molds of varying sizes and/or shapes is to have the clamp platen 305 translate along the base 303 and then locking the clamp platen 305 into a fixed position to the base 303. A clamping-hydraulic column 380 and a mold-break hydraulic column 381 are defined between the clamp piston 342 and the housing 379.

A lock 313 includes a sleeve 326 that has an outer surface 309 that threadably engages the clamp piston 342. The sleeve 326 includes an inner surface 311, and the teeth 329 extend from the surface 311 and so that the teeth 329 may cooperate with the teeth 314. It is understood that FIG. 18 shows

the clamp assembly 308 in an un-actuated condition (that is, the clamp assembly 308 is not yet actuated to apply a force, either clamping force or mold-break force, that is transferable over to the mold halves 392, 394).

5 The description of the exemplary embodiments provides examples of the present invention, and these examples do not limit the scope of the present invention. It is understood that the scope of the present invention is limited by the claims. The concepts described above may be adapted for specific conditions and/or functions, and may be further extended to a variety of other applications that are within the scope of the present invention. Having thus described the exemplary embodiments, it will
10 be apparent that modifications and enhancements are possible without departing from the concepts as described. Therefore, what is to be protected by way of letters patent are limited only by the scope of the following claims:

WHAT IS CLAIMED IS:

1. A molding-system lock (113; 213; 313), comprising:

a sleeve (126; 226; 326) operatively accommodating locking and unlocking of a platen bar (106; 206; 306) of a molding system (100; 200; 300), and operatively accommodating mold shut-height adjustment of the platen bar (106; 206; 306).

2. The molding-system lock (113; 213; 313) of claim 1, wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being placable, at a lock-clearance condition, in a lock-registration position relative to bar-interrupted teeth (114; 214; 314) of the platen bar (106; 206; 306), placement of the sleeve-interrupted teeth (129; 229; 329) in the lock-clearance condition takes into account shut-height adjustment for mold replacement.

3. The molding-system lock (113; 213; 313) of claim 1, wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being movable away from a lockable-engagement condition with bar-interrupted teeth (114; 214; 314) to a lock-clearance condition in which the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) cannot become interlocked.

4. The molding-system lock (113; 213; 313) of claim 1, wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being movable, after placement of the sleeve-interrupted teeth 129 takes into account shut height adjustment for mold replacement, from a lock-clearance condition to a lockable-engagement condition with bar-interrupted teeth (114; 214; 314), wherein upon mold closure, the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) are registered to be interlockable.

5. The molding-system lock (113) of claim 1, wherein the platen bar (106) is intractable with a clamp (108) connected to a stationary platen (102).

6. The molding-system lock (113) of claim 1, wherein the platen bar (106) is intractable with a clamp (108) connected to a stationary platen (102), and the platen bar (106) is movable relative to a movable platen (104).

7. The molding-system lock (113) of claim 1, wherein the platen bar (106) is interactable with a clamp (108) connected to a stationary platen (102), the platen bar (106) is movable relative to a movable platen (104), and sleeve-interrupted teeth (129) of the sleeve (126) are interactable with the

movable platen (104).

8. The molding-system lock (113) of claim 1, wherein the platen bar (106) is interactable with a clamp (108) connected to a stationary platen (102), the platen bar (106) is movable relative to a movable platen (104), and the sleeve (126) has an outer surface (109) being movably interactable with a platen insert (120), the platen insert (120) being connected to the movable platen (104).

9. The molding-system lock (213; 313) of claim 1, wherein the platen bar (206; 306) is fixedly attachable to a movable platen (204; 304).

10. The molding-system lock (213) of claim 1, wherein the platen bar (206) is fixedly attachable to a movable platen (204), and the platen bar (206) is movable relative to a stationary platen (202).

11. The molding-system lock (213) of claim 1, wherein the platen bar (206) is fixedly attachable to a movable platen (204), the platen bar (206) is movable relative to a stationary platen (202), and sleeve-interrupted teeth (229) of the sleeve (126) are interactable with a clamp (208).

12. The molding-system lock (213) of claim 1, wherein the platen bar (206) is fixedly attachable to a movable platen (204), the platen bar (206) is movable relative to a stationary platen (202), and sleeve-interrupted teeth (229) of the sleeve (226) are interactable with a clamp (208), the clamp (208) mountable to the stationary platen (202).

13. The molding-system lock (313) of claim 1, wherein the platen bar (306) is fixedly attachable to a movable platen (304), and sleeve-interrupted teeth (329) of the sleeve (326) are interactable with a clamp (308).

14. The molding-system lock (313) of claim 1, wherein the platen bar (306) is fixedly attachable to a movable platen (304), and sleeve-interrupted teeth (329) of the sleeve (326) are interactable with a clamp (308), the clamp (308) mountable to a clamp block (305).

15. A molding-system lock (113; 213; 313), comprising:

a sleeve (126; 226; 326) operatively accommodating locking and unlocking of a platen bar (106; 206; 306) of a molding system (100; 200; 300), and operatively accommodating mold shut-height adjustment of the platen bar (106; 206; 306),

wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being:

placable, at a lock-clearance condition, in a lock-registration position relative to bar-

interrupted teeth (114; 214; 314) of the platen bar (106; 206; 306), placement of the sleeve-interrupted teeth (129; 229; 329) in the lock-clearance condition takes into account shut-height adjustment for mold replacement,

movable away from a lockable-engagement condition with bar-interrupted teeth (114; 214; 314) to a lock-clearance condition in which the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) cannot become inter-locked,

movable, after placement of the sleeve-interrupted teeth 129 takes into account shut height adjustment for mold replacement, from a lock-clearance condition to a lockable-engagement condition with bar-interrupted teeth (114; 214; 314), wherein upon mold closure, the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) are registered to be interlockable.

16. A molding system (100; 200; 300), comprising:

a molding-system lock (113; 213; 313), including:

a sleeve (126; 226; 326) operatively accommodating locking and unlocking of a platen bar (106; 206; 306), and operatively accommodating mold shut-height adjustment of the platen bar (106; 206; 306).

17. The molding system (100; 200; 300) of claim 16, wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being placable, at a lock-clearance condition, in a lock-registration position relative to bar-interrupted teeth (114; 214; 314) of the platen bar (106; 206; 306), placement of the sleeve-interrupted teeth (129; 229; 329) in the lock-clearance condition takes into account shut-height adjustment for mold replacement.

18. The molding system (100; 200; 300) of claim 16, wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being movable away from a lockable-engagement condition with bar-interrupted teeth (114; 214; 314) to a lock-clearance condition in which the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) cannot become inter-locked.

19. The molding system (100; 200; 300) of claim 16, wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being movable, after placement of the sleeve-interrupted teeth 129 takes into account shut height adjustment for mold replacement, from a lock-clearance condition to a lockable-engagement condition with bar-interrupted teeth (114; 214; 314), wherein upon mold closure, the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) are registered to be interlockable.

20. The molding system (100) of claim 16, wherein the platen bar (106) is intractable with a clamp (108) connected to a stationary platen (102).

21. The molding system (100) of claim 16, wherein the platen bar (106) is intractable with a clamp (108) connected to a stationary platen (102), and the platen bar (106) is movable relative to a movable platen (104).

22. The molding system (100) of claim 16, wherein the platen bar (106) is interactable with a clamp (108) connected to a stationary platen (102), the platen bar (106) is movable relative to a movable platen (104), and sleeve-interrupted teeth (129) of the sleeve (126) are interactable with the movable platen (104).

23. The molding system (100) of claim 16, wherein the platen bar (106) is interactable with a clamp (108) connected to a stationary platen (102), the platen bar (106) is movable relative to a movable platen (104), and the sleeve (126) has an outer surface (109) being movably interactable with a platen insert (120), the platen insert (120) being connected to the movable platen (104).

24. The molding-system lock (213; 313) of claim 16, wherein the platen bar (206; 306) is fixedly attachable to a movable platen (204; 304).

25. The molding system (200) of claim 16, wherein the platen bar (206) is fixedly attachable to a movable platen (204), and the platen bar (206) is movable relative to a stationary platen (202).

26. The molding system (200) of claim 16, wherein the platen bar (206) is fixedly attachable to a movable platen (204), the platen bar (206) is movable relative to a stationary platen (202), and sleeve-interrupted teeth (229) of the sleeve (126) are interactable with a clamp (208).

27. The molding system (200) of claim 16, wherein the platen bar (206) is fixedly attachable to a movable platen (204), the platen bar (206) is movable relative to a stationary platen (202), and sleeve-interrupted teeth (229) of the sleeve (226) are interactable with a clamp (208), the clamp (208) mountable to the stationary platen (202).

28. The molding system (300) of claim 16, wherein the platen bar (306) is fixedly attachable to a movable platen (304), and sleeve-interrupted teeth (329) of the sleeve (326) are interactable with a clamp (308).

29. The molding system (300) of claim 16, wherein the platen bar (306) is fixedly attachable to a movable platen (304), and sleeve-interrupted teeth (329) of the sleeve (326) are interactable with a clamp (308), the clamp (308) mountable to a clamp block (305).

5 30. A molding system lock (100; 200; 300), comprising:

a sleeve (126; 226; 326) operatively accommodating locking and unlocking of a platen bar (106; 206; 306), and operatively accommodating mold shut-height adjustment of the platen bar (106; 206; 306),

wherein the sleeve (126; 226; 326) has sleeve-interrupted teeth (129; 229; 329) being:

10 placable, at a lock-clearance condition, in a lock-registration position relative to bar-interrupted teeth (114; 214; 314) of the platen bar (106; 206; 306), placement of the sleeve-interrupted teeth (129; 229; 329) in the lock-clearance condition takes into account shut-height adjustment for mold replacement,

movable away from a lockable-engagement condition with bar-interrupted teeth (114; 214; 314) to a lock-clearance condition in which the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) cannot become inter-locked,

movable, after placement of the sleeve-interrupted teeth 129 takes into account shut height adjustment for mold replacement, from a lock-clearance condition to a lockable-engagement condition with bar-interrupted teeth (114; 214; 314), wherein upon mold closure, the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) are registered to be interlockable.

31. A method, comprising:

25 using a sleeve (126; 226; 326) of a molding-system lock (113; 213; 313) to operatively accommodate locking and unlocking of a platen bar (106; 206; 306) of a molding system (100; 200; 300), and to operatively accommodate mold shut-height adjustment of the platen bar (106; 206; 306).

32. The method of claim 31, further comprising:

30 placing sleeve-interrupted teeth (129; 229; 329) of the sleeve (126; 226; 326), at a lock-clearance condition, in a lock-registration position relative to bar-interrupted teeth (114; 214; 314) of the platen bar (106; 206; 306), placement of the sleeve-interrupted teeth (129; 229; 329) in the lock-clearance condition takes into account shut-height adjustment for mold replacement.

33. The method of claim 31, further comprising:

35 moving sleeve-interrupted teeth (129; 229; 329) of the sleeve (126; 226; 326) away from a lockable-engagement condition with bar-interrupted teeth (114; 214; 314) to a lock-clearance

condition in which the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) cannot become inter-locked.

34. The method of claim 31, further comprising:

5 moving sleeve-interrupted teeth (129; 229; 329) of the sleeve (126; 226; 326), after placement of the sleeve-interrupted teeth 129 takes into account shut height adjustment for mold replacement, from a lock-clearance condition to a lockable-engagement condition with bar-interrupted teeth (114; 214; 314), wherein upon mold closure, the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) are registered to be interlockable.

10 35. The method of claim 31, further comprising:

replacing a mold attached to the platen with another mold attachable to the platen, and moving the sleeve (126; 226; 326) to effect shut height adjustment of a mold.

15 36. A method, comprising:

using a sleeve (126; 226; 326) of a molding-system lock (113; 213; 313) to operatively accommodate locking and unlocking of a platen bar (106; 206; 306) of a molding system (100; 200; 300), and to operatively accommodate mold shut-height adjustment of the platen bar (106; 206; 306);

20 placing sleeve-interrupted teeth (129; 229; 329) of the sleeve (126; 226; 326), at a lock-clearance condition, in a lock-registration position relative to bar-interrupted teeth (114; 214; 314) of the platen bar (106; 206; 306), placement of the sleeve-interrupted teeth (129; 229; 329) in the lock-clearance condition takes into account shut-height adjustment for mold replacement;

25 moving the sleeve-interrupted teeth (129; 229; 329) of the sleeve (126; 226; 326) away from a lockable-engagement condition with bar-interrupted teeth (114; 214; 314) to a lock-clearance condition in which the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) cannot become inter-locked;

30 moving the sleeve-interrupted teeth (129; 229; 329) of the sleeve (126; 226; 326), after placement of the sleeve-interrupted teeth 129 takes into account shut height adjustment for mold replacement, from a lock-clearance condition to a lockable-engagement condition with bar-interrupted teeth (114; 214; 314), wherein upon mold closure, the sleeve-interrupted teeth (129; 229; 329) and the bar-interrupted teeth (114; 214; 314) are registered to be interlockable.

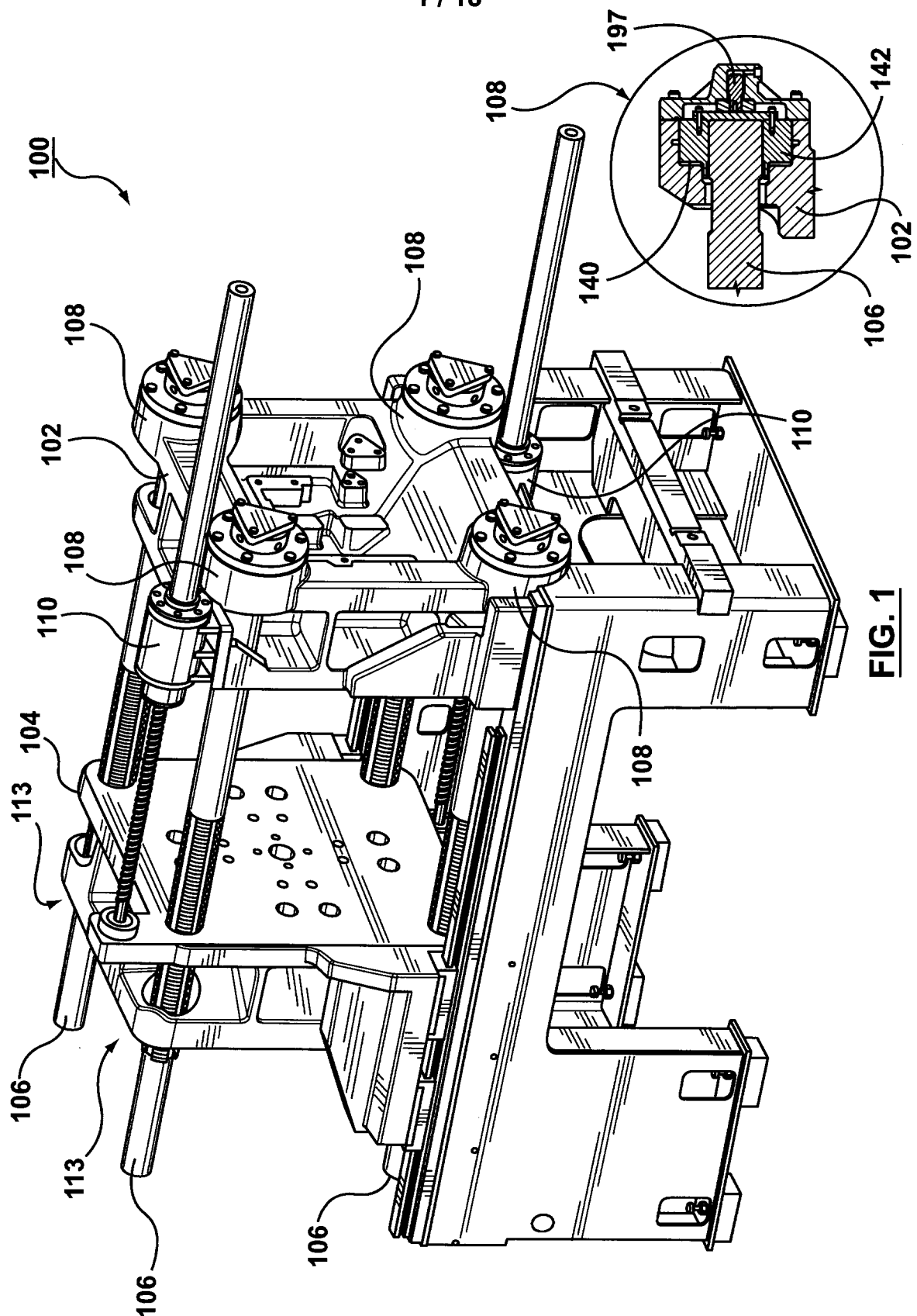
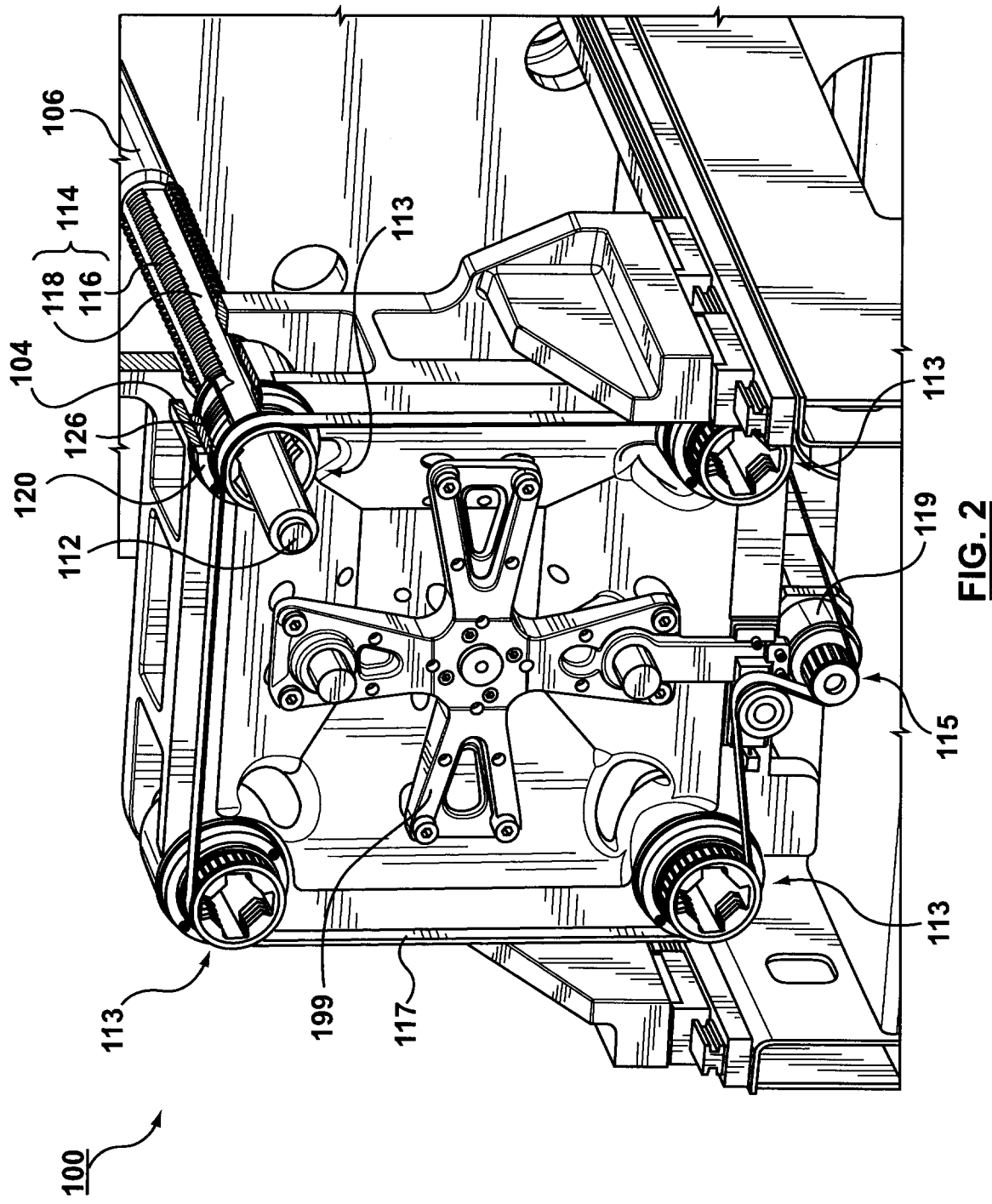
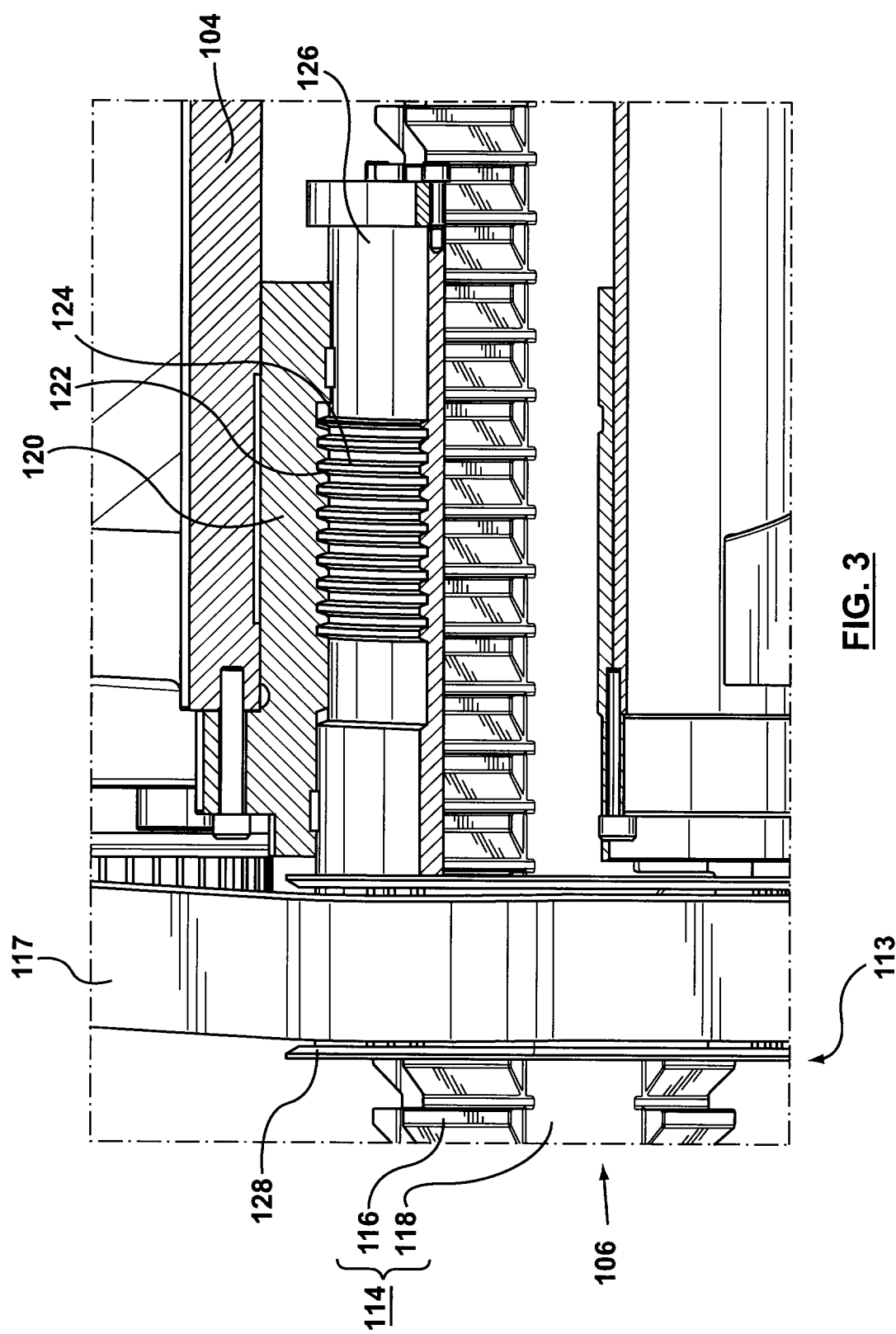


FIG. 1





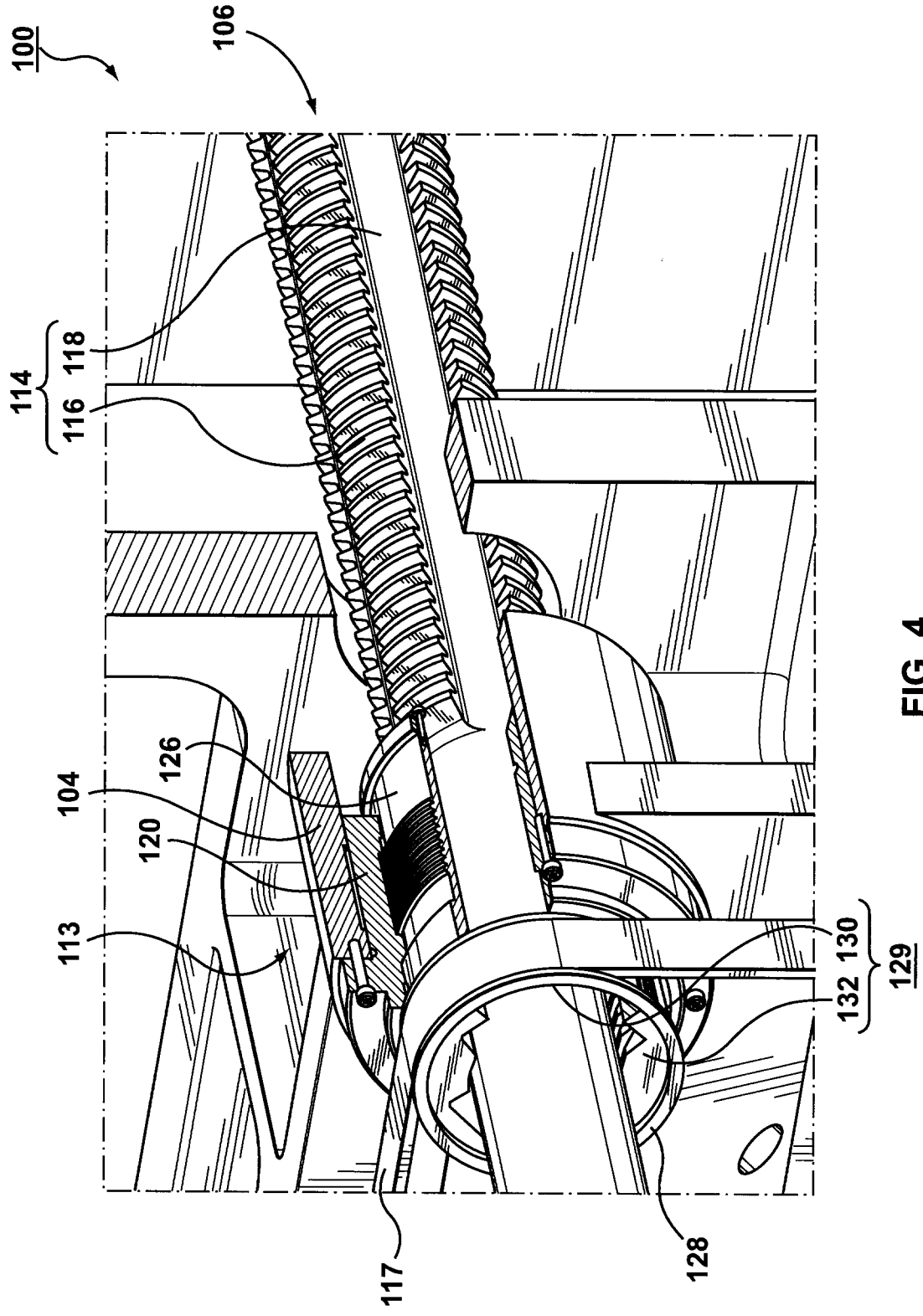


FIG. 4

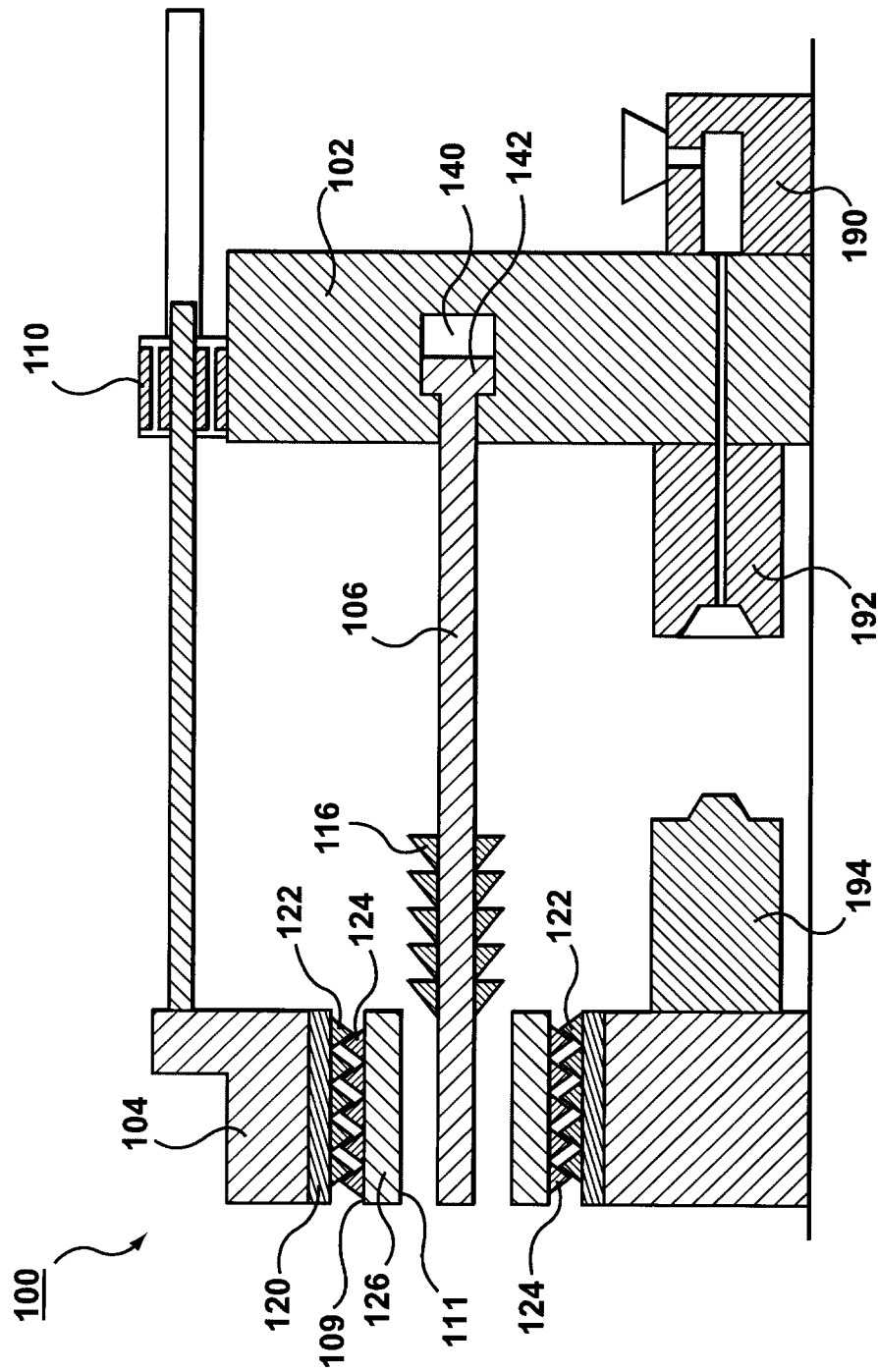
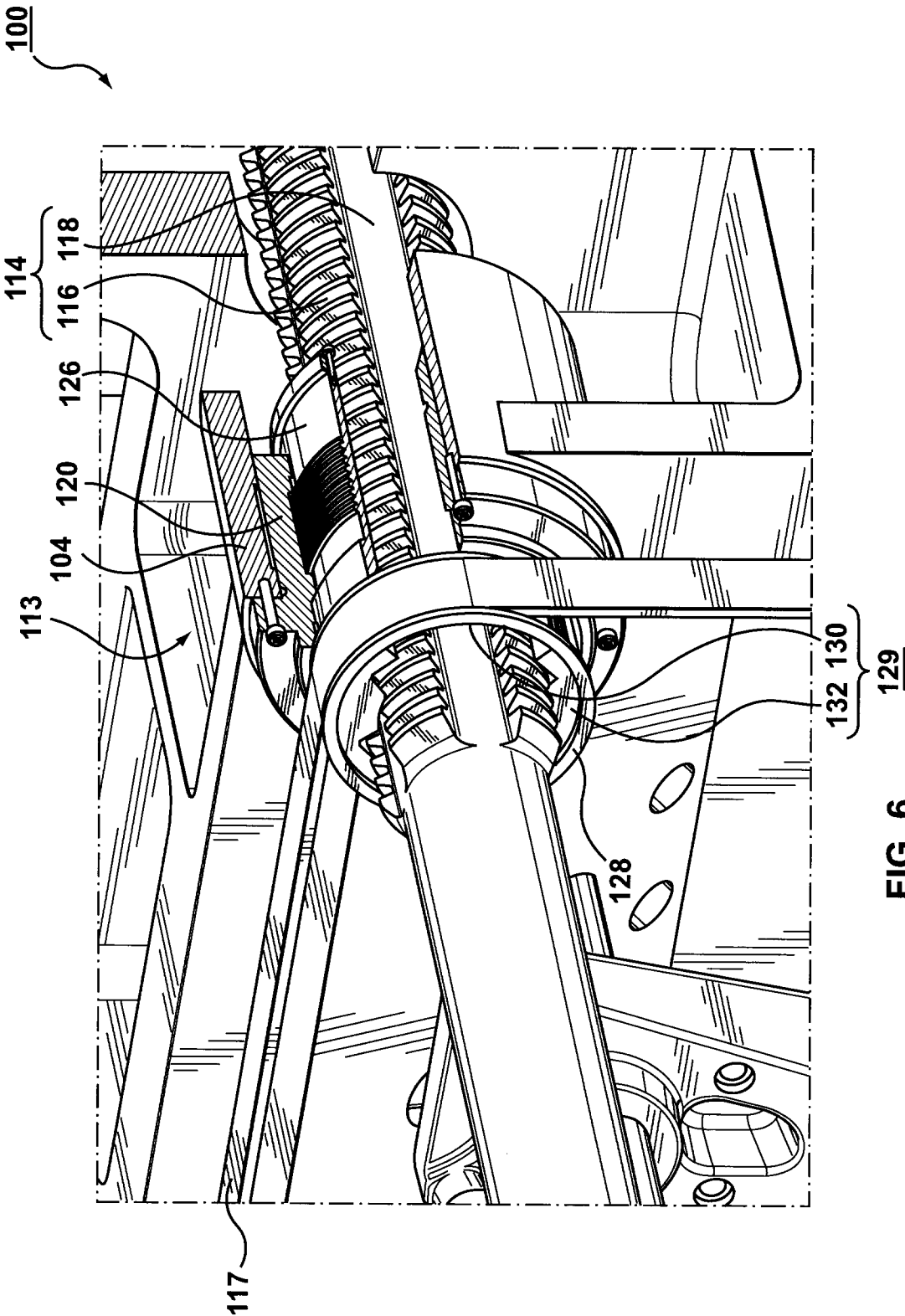


FIG. 5



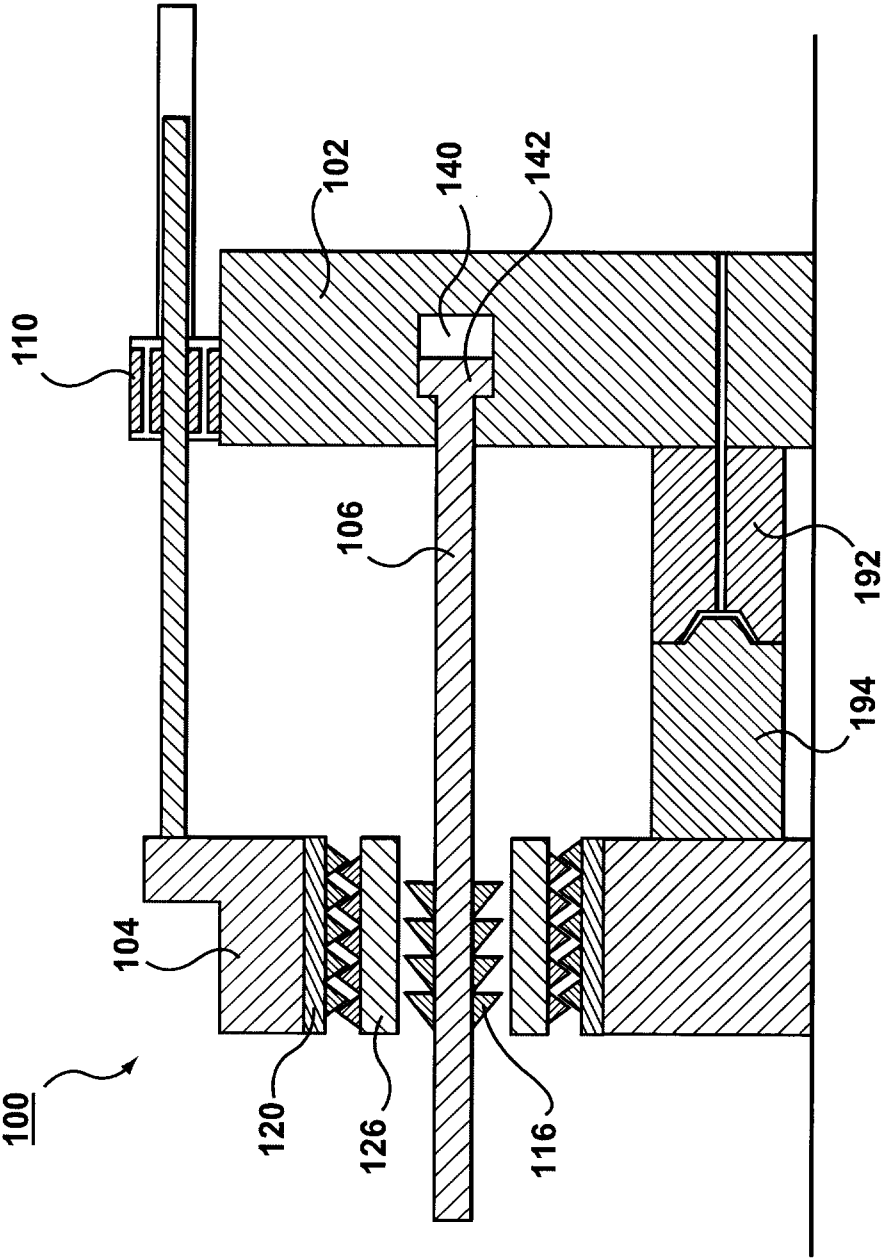


FIG. 7

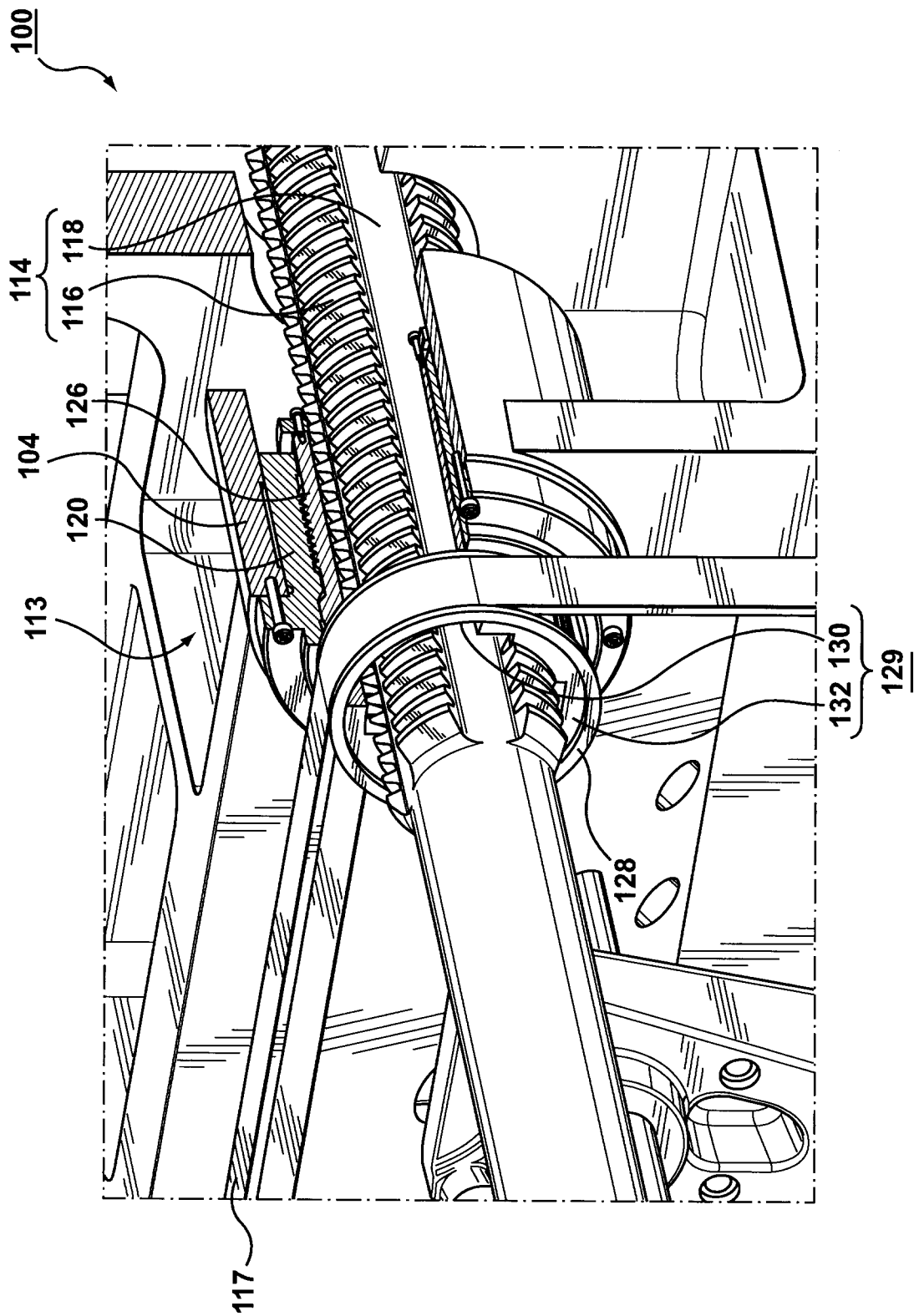


FIG. 8

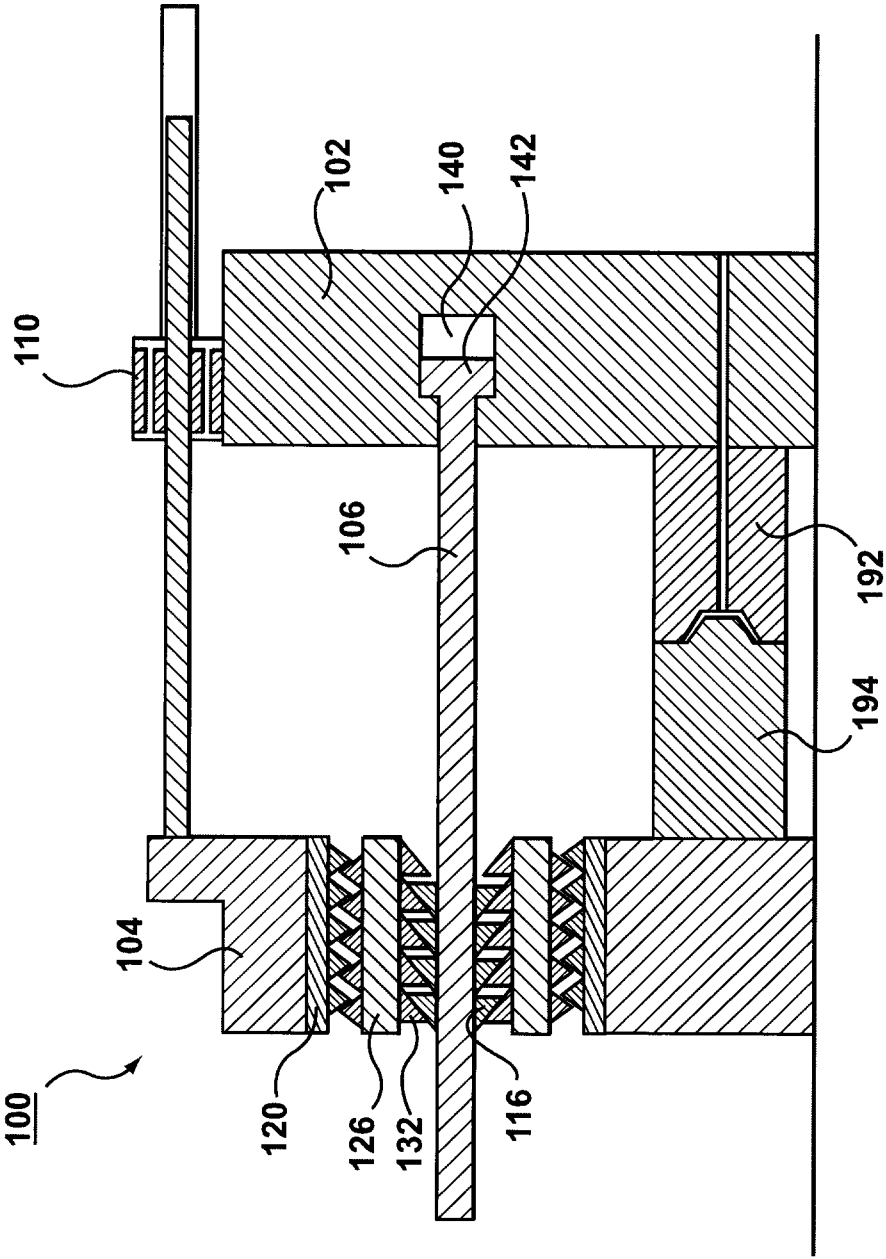


FIG. 9

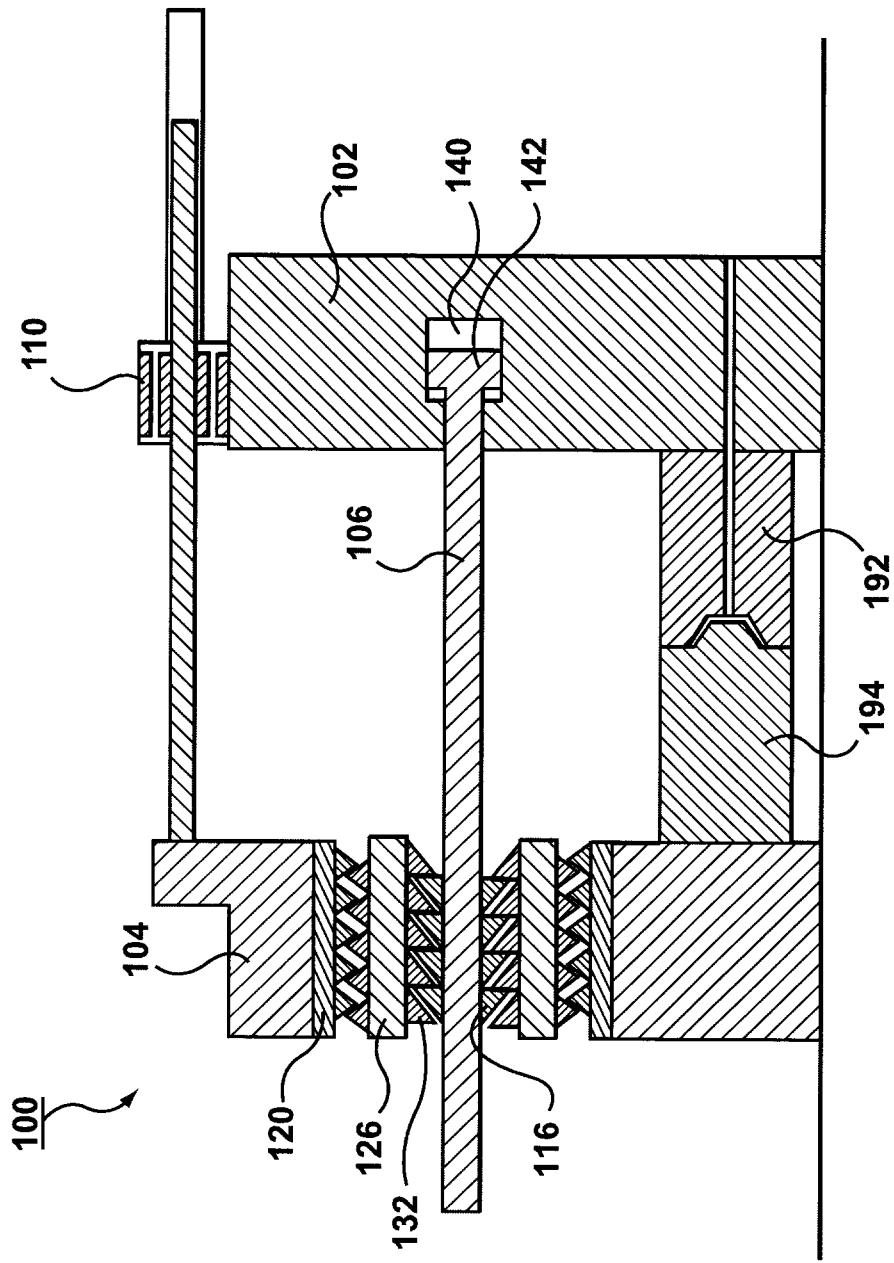


FIG. 10

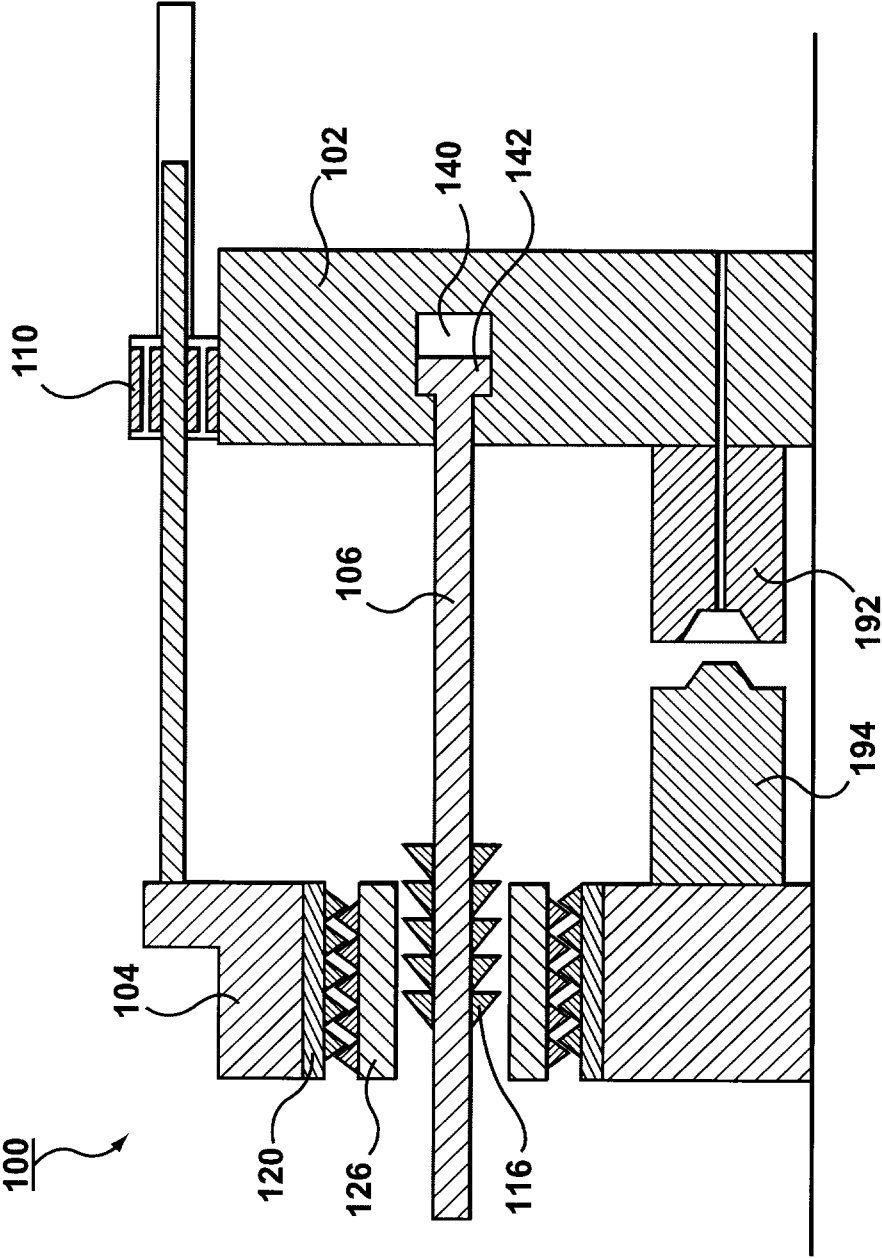


FIG. 11

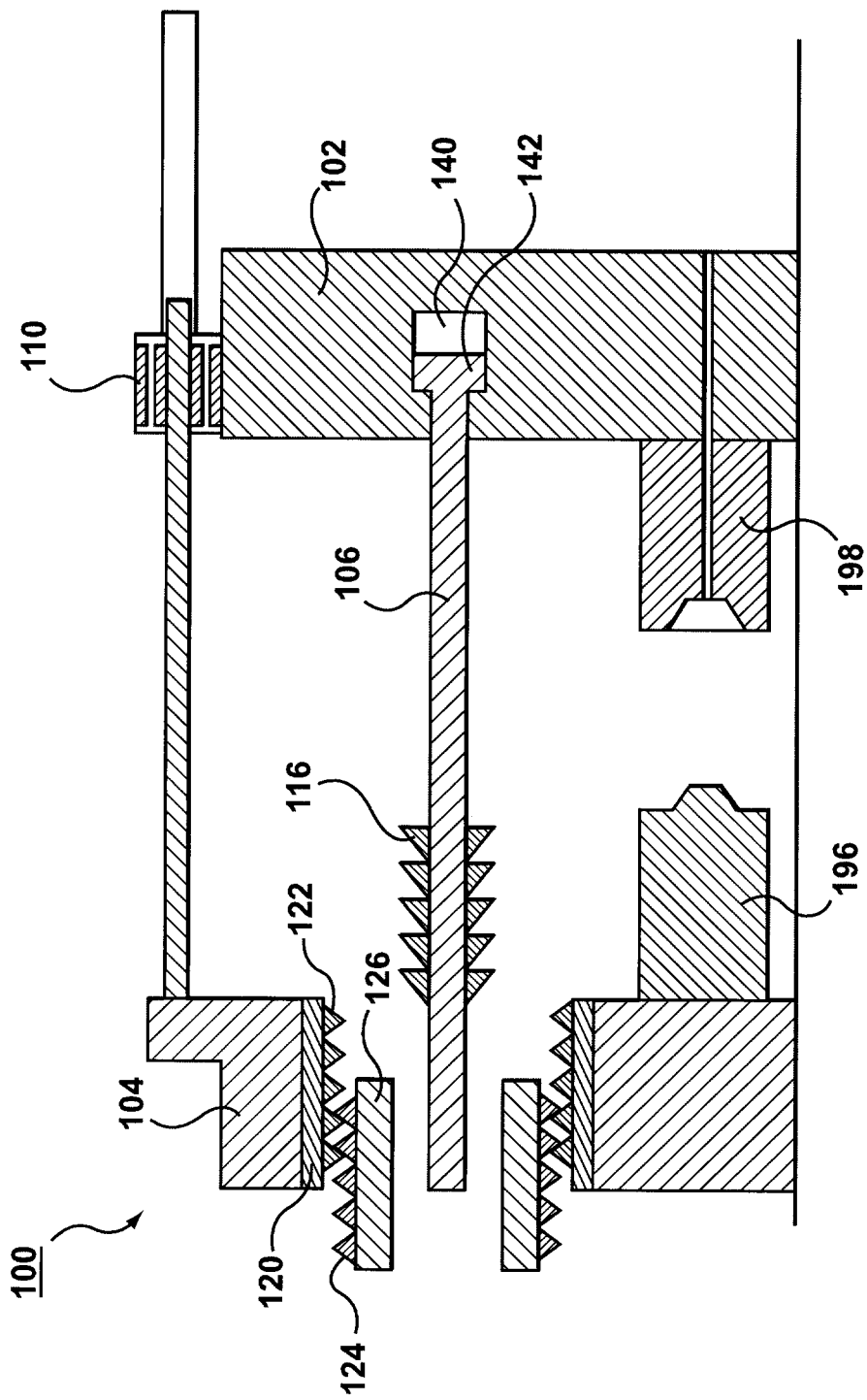


FIG. 12

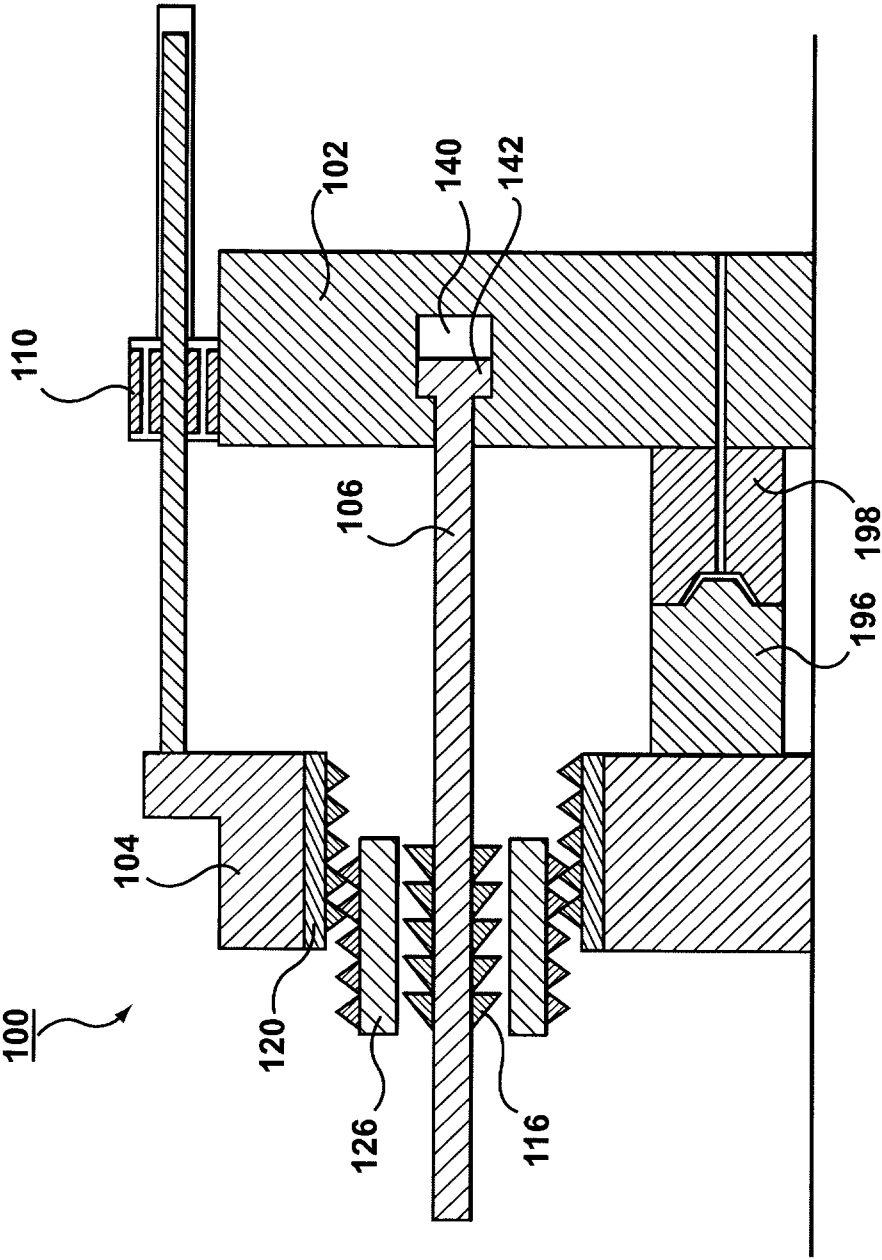


FIG. 13

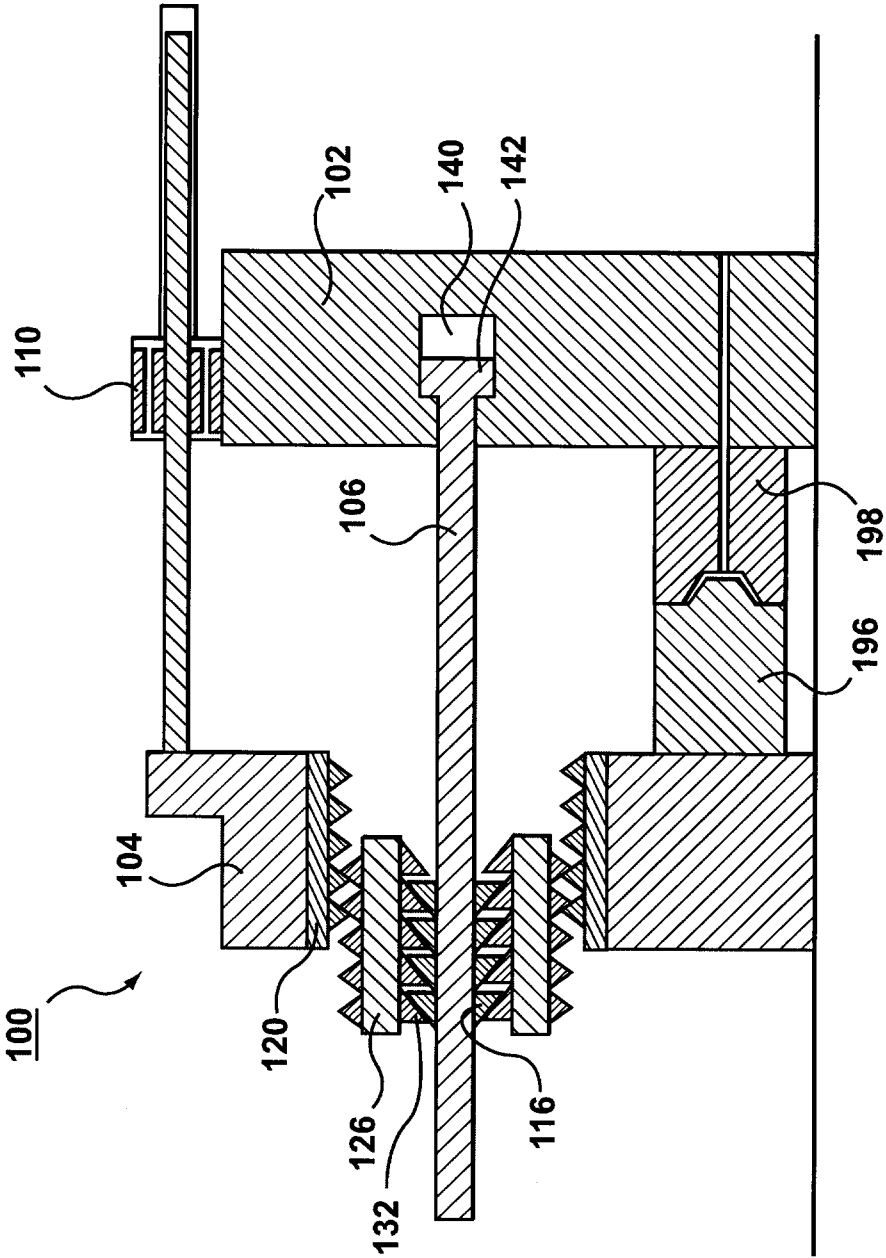


FIG. 14

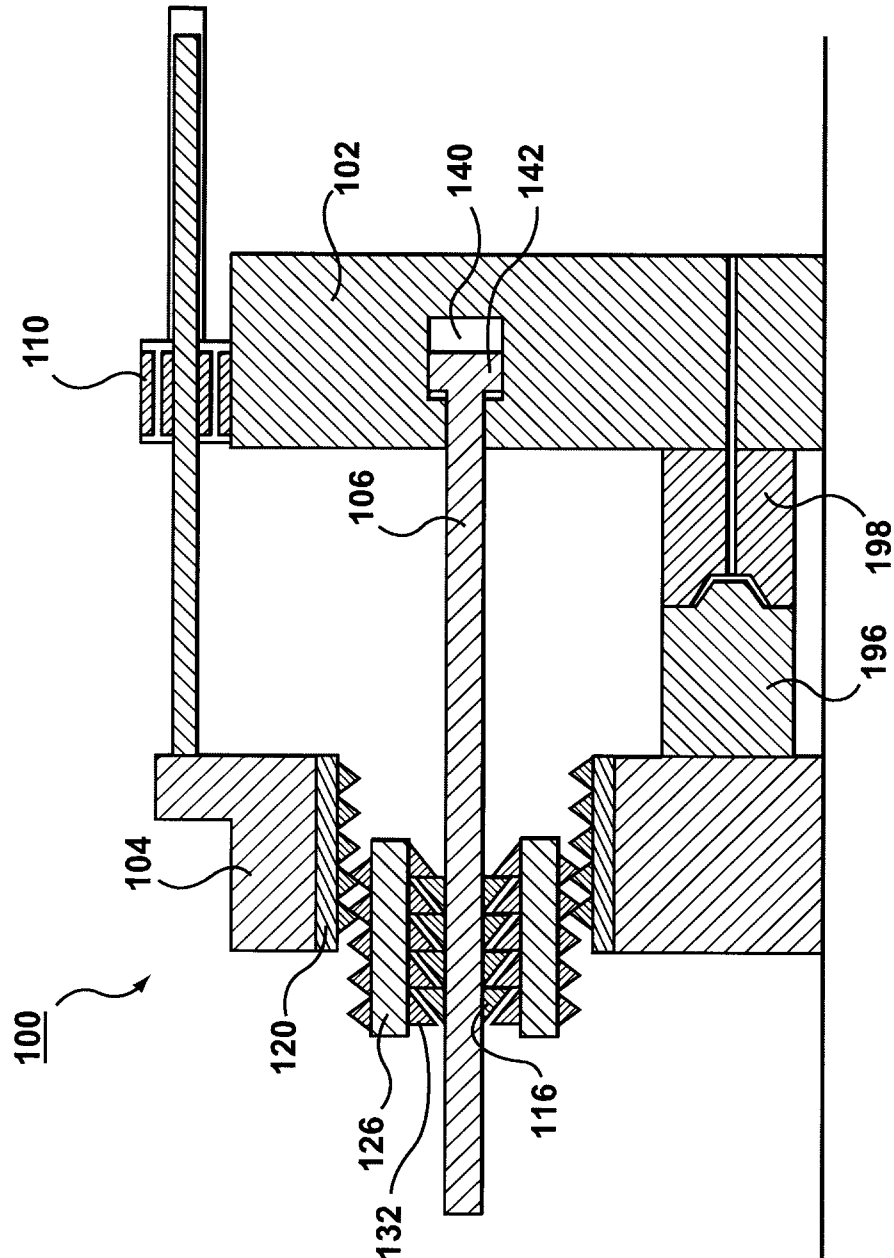


FIG. 15

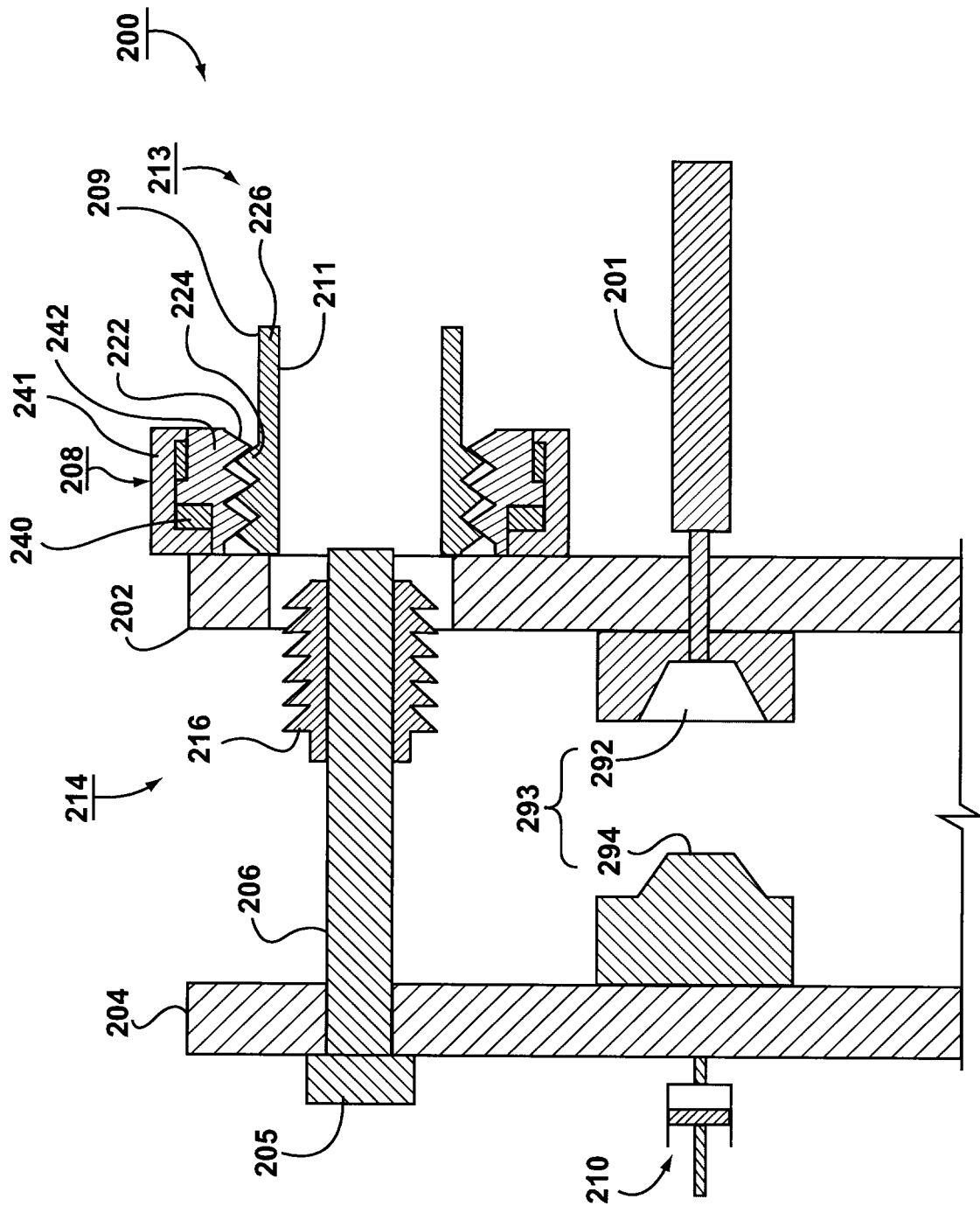


FIG. 16

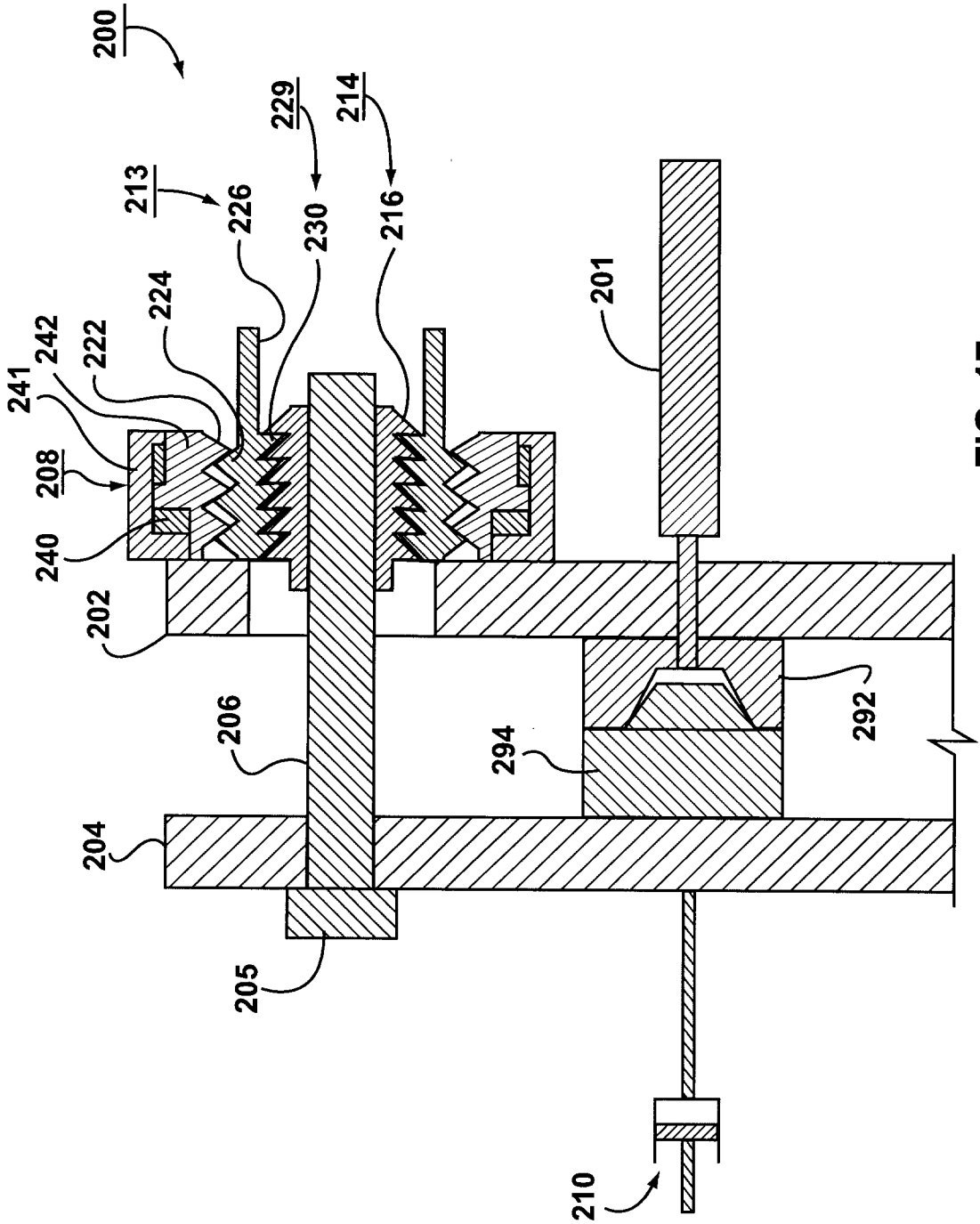


FIG. 17

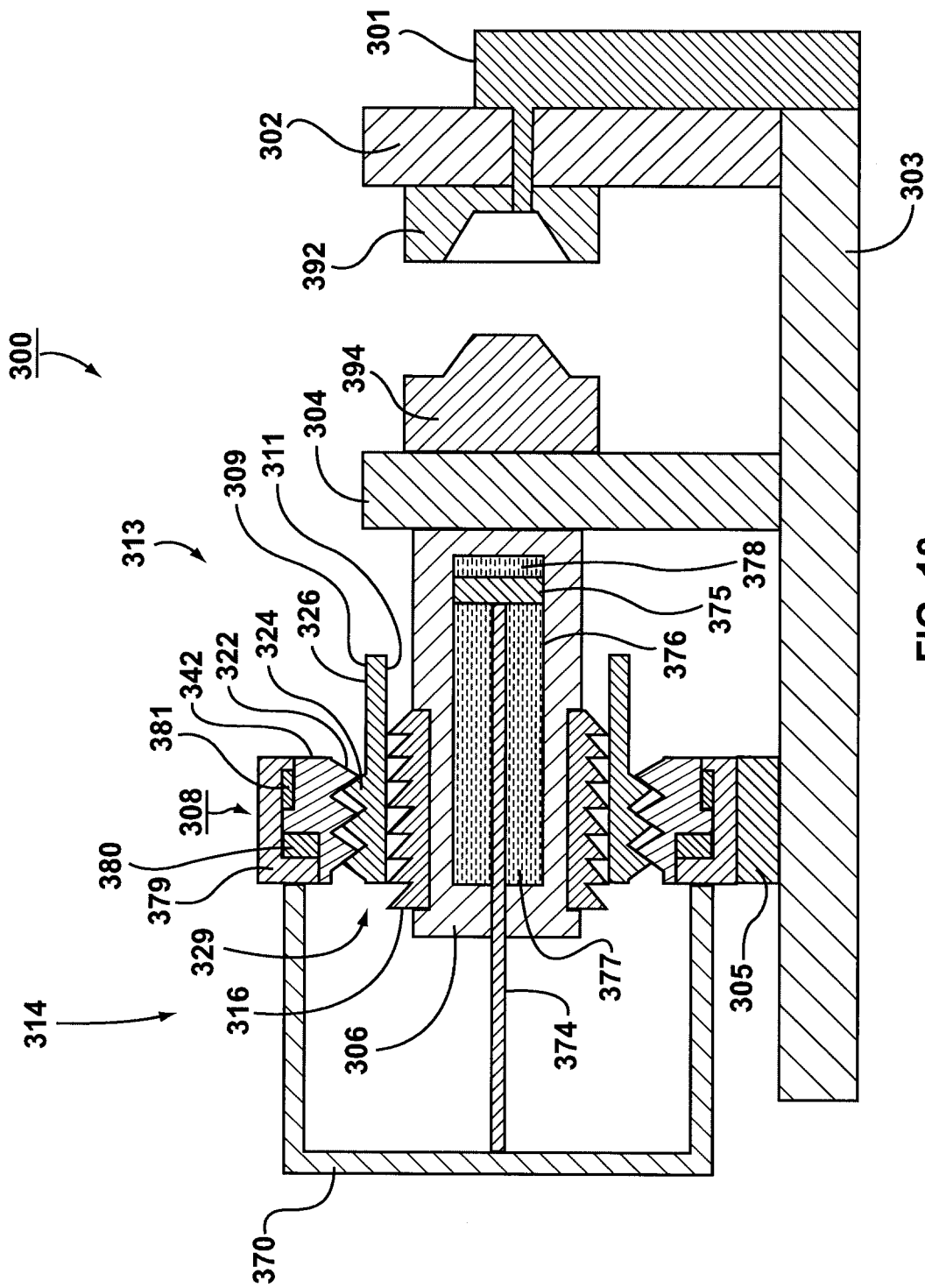


FIG. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2007/000878

A. CLASSIFICATION OF SUBJECT MATTER

IPC: **B29C 45/64** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: **B29C**(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)

Delphion, Derwent, Questel-Orbit (Pluspat), CPD with key words, such as: injection mold/moulding machine, clamping, clamp, clamped, mold/mould closing, tie bar, platen bar, column, height adjustment and thickness adjustment.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CA 2047607 C (HIRATA, H. et al.) 28 January 1992 (28-01-1992) *whole document*	1-36
A	US 6250905 B1 (MAILLIET, P. et al.) 26 June 2001 (26-06-2001) *cited by applicant* *whole document*	1-36

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

2 August 2007 (02-08-2007)

Date of mailing of the international search report

5 September 2007 (05-09-2007)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 001-819-953-2476

Authorized officer

Pengfei Zhang 819- 953-0654

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2007/000878

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