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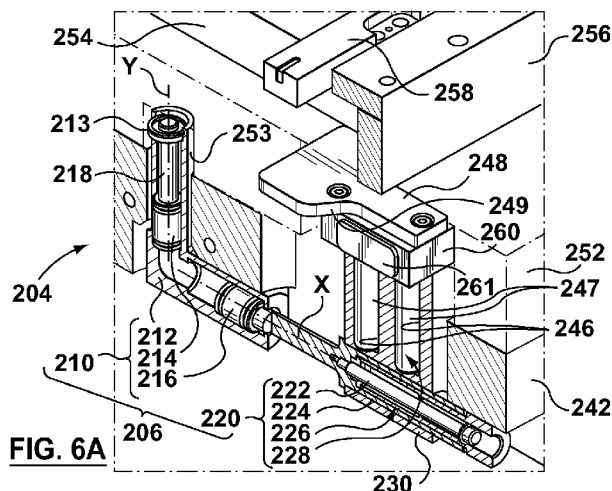
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(54) Title: LINKAGE ASSEMBLY FOR USE IN AN INJECTION MOLD



(57) Abstract: Disclosed herein, amongst other things, is a linkage assembly (206, 306, 406, 506, 606) for use with an injection mold (202). The linkage assembly (206, 306, 406, 506, 606), includes a force translator (210, 310, 410, 510, 610) having a first engager (214, 314, 414, 514, 614) and a second engager (216, 316, 416, 516, 616), wherein the first engager (214, 314, 414, 514, 614) and the second engager (216, 316, 416, 516, 616) are connected by a medium for coordinated movement thereof. In accordance with a non-limiting embodiment, the linkage assembly may be incorporated into a stripper assembly of the injection mold.



LINKAGE ASSEMBLY FOR USE IN AN INJECTION MOLD

TECHNICAL FIELD

Non-Limiting embodiments disclosed herein generally relate to a linkage assembly for use in an injection mold and more particularly, but not limited to, the incorporation thereof into a stripper assembly of the injection mold.

BACKGROUND OF THE INVENTION

With reference to FIG. 1 there is depicted a schematic representation of an injection molding system 100 familiar to those of ordinary skill in the art. The injection molding system 100 is configured to operate an injection mold 102 for molding a molded article (not shown) such as, for example, a preform (not shown) of the type that is subsequently blow moldable to form a container (not shown).

A brief description of the injection molding system 100 and the injection mold 102 follows. A detailed description of these known components may be referenced, at least in part, in the following reference books (for example): (i) "Injection Molding Handbook" authored by OSSWALD/TURNIG/GRAMANN (ISBN: 3-446-21669-2), (ii) "Injection Molding Handbook" authored by ROSATO AND ROSATO (ISBN: 0-412-10581-3), (iii) "Injection Molding Systems" 3rd Edition authored by JOHANNABER (ISBN 3-446-17733-7) and/or (iv) "Runner and Gating Design Handbook" authored by BEAUMONT (ISBN 1-446-22672-9).

The injection molding system 100 shown in FIG. 1 is shown to include, but is not limited to, a clamping assembly 196, the injection mold 102 arranged in the clamping assembly 196 and an injection assembly.

The clamping assembly 196 includes, amongst other things, a moving platen 112, a stationary platen 114, a clamp block 113, and a tie bar 116. The tie bar 116 links the stationary platen 114 with the clamp block 113, and moreover slidably supports the moving platen 112 thereon. While not shown it is typical to provide four such tie bars 116, one extending between each of the four corners of the moving platen 112, the stationary platen 114, and the clamp block 113. The clamping assembly 196 also includes a platen-moving

actuator 115 that is connected between the moving platen 112 and the clamp block 113. The platen-moving actuator 115 is operable, in use, to move the moving platen 112 with respect to the stationary platen 114 and thus a first mold portion 104 relative to a second mold portion 106 of the injection mold 102 that are mountable thereto, respectively. The clamping assembly 196 further includes a clamp actuator 118 and a clamp shutter 120 in association with the clamp block 113, wherein the clamp shutter 120 is operable, in use, to selectively connect the clamp actuator 118 with the moving platen 112 for sake of a clamping together of the first mold portion 104 and the second mold portion 106. Lastly, the clamping assembly 196 may also include an ejector actuator 122 (such as, for example, a hydraulic actuator, a pneumatic actuator, an electro-mechanical actuator, or the like) that is associated with the moving platen 112. The ejector actuator 122 is connectable, in use, to a stripper assembly 150 that is associated with the first mold portion 104. The stripper assembly 150 is operable, in use, to eject the molded article from a mold stack 180.

As depicted with reference to FIGS. 2, 3A and 3B, the injection mold 102, and more specifically the stripper assembly 150, may include, for example, structure and operational steps in accordance with the teachings of US Patent 7,766,644 to Li, published on August 3, 2010. As such, the stripper assembly includes a stripper plate 152 upon which slide pair members 154 are slidably arranged for positioning of split mold inserts 184 of the mold stack 180 that are connected thereto between a molding configuration (as shown and also with reference to FIG. 3A) and an ejection configuration (FIG. 3B). In the molding configuration the split mold inserts 184 define an encapsulated portion of a molding cavity. In the ejection configuration the split mold inserts 184 open to release an encapsulated portion of the molded article. In operation, the stripper assembly 150 is selectively positioned by the ejector actuator 122 (FIG. 1), along a mold-stroke axis, between a retracted position (FIG. 3A) and an extended position (FIG. 3B) relative to a core assembly 140 of the first mold portion 104. Sliding movement of the slide pair members 154, generally perpendicular to the mold-stroke axis, is driven by a linkage assembly that comprises a cam 156 that is mounted to the core assembly 140, wherein the movement of the slide pair members 154 is linked with the movement of the stripper assembly 150 relative to the core assembly 140.

Other examples of stripper assemblies and related linkage assemblies that are known to those of ordinary skill in the art may be found with reference to the following publications in which:

US Patent 3,805,577 to Bergemann, published on April 23, 1974 discloses an ejector assembly provides for a very rapid removal of a workpiece from a forming machine by an assembly which includes a pair of ejector members operating through a hydraulic chamber. A first ejector member of the pair is directly linked to a reciprocating portion of the machine so as to follow each forming and return stroke of the machine, and the second ejector member responds to a movement of the first ejector member only during a return stroke of the machine to effect an immediate removal of a workpiece from the machine. A differential rate of travel is provided between the pair of ejector members to provide a gradually increasing clearance between the workpiece and one forming surface of the machine so that the second ejector member can immediately respond to a return stroke of the machine to cause a very rapid separation of the workpiece from a forming surface of the machine.

US patent 4,896,524 to Gustafsson, published on January 30, 1990 discloses an arrangement for the ejection of a pressed component from a press tool. The arrangement consists of a number of ejection pins distributed over the press surface tool. Each of the ejection pins is so arranged as to lie during the pressing operation with its tip no higher than on a level with the aforementioned press surface, and, in conjunction with the opening of the tool after a pressing operation has been completed, as to eject the component from the tool with its tip. A characteristic feature of the invention is that each ejection pin is operatively connected via a piston rod to a hydraulic piston. The piston is capable of axial displacement in a hydraulic cylinder, which is filled with an incompressible fluid in space between the piston and an end wall of the cylinder. The space communicates via a duct with a drive unit for the ejection pin.

US Patent 6,799,962 to Mai., published on October 5, 2004 discloses a stripper assembly for an injection molding machine comprising at least one slide pair having a first slide and a second slide and actuation means operatively coupled to said first slide for moving the first slide in a first direction. According to an important aspect of the invention, the stripper assembly further comprises transmission means operatively coupled to said first slide and said second slide for transforming the movement of the first slide in the first direction in a movement of the second slide in a second direction, the second direction being opposite to the first direction.

United States Patent Application Publication No. 2007/005939 to Serniuck et al, published on March 15, 2007 discloses a molded article handling device, an apparatus, and a system. The device, the apparatus and the system include a slide bar configured to have a mold portion configured to mold, in cooperation with complementary mold halves of a molding machine, a molded article. The slide bar is also configured to be actuatable by an actuator. The actuator is configured to move the slide bar towards selectable positions, and the selectable positions located between travel terminus points.

US Patent 7,540,740 to Hofstetter, published on June 2, 2009 discloses a form tool for injection-molding molded articles, especially PET parisons. The form tool comprises a base plate and a stripper plate having a slide. A plurality of separable male mold cones is provided on the slide. For removing the parisons, the male mold cones are completely opened using a hydraulic drive instead of an inclined drag element.

SUMMARY OF THE INVENTION

In accordance with a general aspect there is provided a linkage assembly for use with an injection mold. The linkage assembly, includes a force translator having a first engager and a second engager, wherein the first engager and the second engager are connected by a medium for coordinated movement thereof.

In accordance with a more specific aspect, the linkage assembly may be incorporated into a stripper assembly of the injection mold. More particularly, the first movable mold member may include a stripper assembly of a first mold portion of the injection mold whereas the second movable mold member may include a pair of slides that are associated with the stripper assembly.

In accordance with a more specific aspect, there is provided a slide engager for use with the linkage assembly. The slide engager includes a main body that is configured to be supported by a stripper assembly of an injection mold and a cam that is associated with the main body, the cam defines a cam profile with which to engage a cam follower that is associated with one of a pair of slides that are associated with the stripper assembly, wherein relative motion between the pair of slides is provided with the relative motion between the cam and the cam follower.

These and other aspects and features of non-limiting embodiments will now become apparent to those skilled in the art upon review of the following description of specific non-limiting embodiments of the invention in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

The non-limiting embodiments will be more fully appreciated by reference to the accompanying drawings, in which:

FIG. 1 depicts a side view schematic representation of a molding system in accordance with the prior art.

FIG. 2 depicts an isometric view of a first mold portion of an injection mold within the molding system of FIG. 1.

FIG. 3A depicts a section view through the injection mold of FIG. 1 when it is arranged in a molding configuration for molding a molded article (not shown).

FIG. 3B depicts a section view through a first mold portion of the injection mold of FIG. 1, wherein a stripper assembly thereof is arranged in a release configuration that is suitable for releasing an encapsulated portion of the molded article (not shown).

FIGS. 4A-4E each depict a section view through a different non-limiting embodiment of a force translator.

FIG. 5A depicts an isometric front view of a non-limiting embodiment of a first mold portion of an injection mold that incorporates a pair of the linkage assemblies therein.

FIG. 5B depicts an isometric rear view of the first mold portion of FIG. 5A that better reveals the installation of the linkage assemblies therein.

FIG. 6A depicts an isometric section view of the first mold portion of FIG. 5A that reveals the integration of one of the linkage assemblies therein.

FIG. 6B depicts a side section view of the first mold portion of FIG. 5A that further reveals the integration of one of the linkage assemblies therein.

FIG. 6C depicts a section view through a non-limiting embodiment of a linkage assembly, wherein the linkage assembly is depicted in a first operating configuration.

FIG. 6B depicts a section view through the linkage actuator of FIG. 5A in a second operating configuration.

The drawings are not necessarily to scale and may be 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 EMBODIMENT(S)

Reference will now be made in detail to various non-limiting embodiment(s) of a linkage assembly for use in an injection mold (not shown). It should be understood that other non-limiting embodiment(s), modifications and equivalents will be evident to one of ordinary skill in the art in view of the non-limiting embodiment(s) disclosed herein and that these variants should be considered to be within scope of the appended claims.

Furthermore, it will be recognized by one of ordinary skill in the art that certain structural and operational details of the non-limiting embodiment(s) discussed hereafter may be modified or omitted (i.e. non-essential) altogether. In other instances, well known methods, procedures, and components have not been described in detail as not to unnecessarily obscure aspects of the present invention.

With reference to FIGS. 4A through 4E there is depicted several non-limiting embodiments of the linkage assembly, items 206, 306, 406, 506 and 606, respectively, that are each suitable to link together two or more movable mold members of an injection mold (not shown). Without particular limitation, the specific purpose of the two or more movable mold members may include ejection of a molded article from the injection mold, reconfiguring a molding cavity within the injection mold, and/or operation of an in-mold molded article transfer device.

These linkage assemblies 206, 306, 406, 506, 606 each comprise a force translator 210, 310, 410, 510, 610 having a first engager 214, 314, 414, 514, 614 that is configured to engage a first movable mold member (not shown) and a second engager 216, 316, 416, 516, 616 that is configured to engage a second movable mold member (not shown). Furthermore, in each of these non-limiting embodiments, the first engager 214, 314, 414, 514, 614 and the second engager 216, 316, 416, 516, 616 are connected by a medium for coordinated movement thereof. In this way, the force translator 210, 310, 410, 510, 610 is configured to translate motion of the first engager 214, 314, 414, 514, 614 into motion of the second engager 216, 316, 416, 516, 616 (i.e. linked as a master and slave and vice versa).

What is meant by the term 'medium' is any suitable material through which a force may be transferred between the first engager 214, 314, 414, 514, 614 and the second engager 216, 316, 416, 516, 616. The medium is preferably, but not necessarily, an incompressible medium such as a hydraulic fluid or a plurality of solid bodies (e.g. steel bearing balls), or quite simply any other suitable medium that would efficiently transmit a force therethrough. The medium may also be a substance such as a gas or body made from a natural rubber that has a generally incompressible response to a moderate force that is applied thereto.

A broad technical effect of the foregoing may include scavenging available motion/energy from the first movable mold member (not shown) to move the second movable mold member (not shown) to perform a related or an unrelated mold function. In this way it may be possible to use less energy overall thereby reducing cost. It is also believed that the underlying solution disclosed herein may offer improved performance and reliability relative to the known structure and/or steps discussed previously.

The structure of each of the foregoing force translators 210, 310, 410, 510, 610 respectively includes a link body 212, 312, 412, 512, 612 that defines a first bore 215, 315, 415, 515, 615 and a second bore 217, 317, 417, 517, 617. The first bore 215, 315, 415, 515, 615 and the first engager 214, 314, 414, 514, 614 are configured to cooperate such that the first engager 214, 314, 414, 514, 614 is slidable, like a piston, within the first bore 215, 315, 415, 515, 615 along a first axis Y. Likewise, the second bore 217, 317, 417, 517, 617 and the second engager 216, 316, 416, 516, 616 are configured to cooperate such that the

second engager 216, 316, 416, 516, 616 is slidable, like a piston, within the second bore 217, 317, 417, 517, 617 along a second axis X. Furthermore, the first bore 215, 315, 415, 515, 615 and the second bore 217, 317, 417, 517, 617 are connected to define a space 219, 319, 419, 519, 619 between the first engager 214, 314, 414, 514, 614 and the second engager 216, 316, 416, 516, 616 within which to arrange the medium.

In operation, with movement of the first engager 214, 314, 414, 514, 614 within the first bore 215, 315, 415, 515, 615, by virtue of movement of the first movable mold member (not shown) to which the first engager 214, 314, 414, 514, 614 is engageable, the medium is displaced within the space 219, 319, 419, 519, 619 between the first engager 214, 314, 414, 514, 614 and the second engager 216, 316, 416, 516, 616. In turn, the medium forces the second engager 216, 316, 416, 516, 616 to move within the second bore 217, 317, 417, 517, 617, and with it the second movable mold member (not shown) that is engageable therewith. In this way, the second engager 216, 316, 416, 516, 616 is linked by the medium for coordinated movement with the first engager 214, 314, 414, 514, 614 and vice versa.

Distinguishing aspects between the non-limiting embodiments of the force translators 210, 310, 410, 510, 610 include the relative positions and orientation of the first axis Y and the second axis X (as applicable). These non-limiting embodiments were selected to illustrate the flexibility of the force translator 210, 310, 410, 510, 610 to link together movable mold members (not shown) having widely different axes of motion and locations.

In terms of specifics, and with reference to the force translator 210 of FIG. 4A, it may be appreciated that the link body 212 is L-shaped with the first bore 215 and the second bore 217 defined therein such that the first axis Y and the second axis X, respectively, are substantially perpendicular and that the space 219 between them is defined by a right-angle channel (i.e. mutually inclined by 90 degrees). This particular force translator 210 may be useful in an injection mold, for example, where it is desired to translate a force between movable mold members that are perpendicular to one another.

With reference to the force translator 310 of FIG. 4B, it may be appreciated that the link body 312 is substantially tubular with the first bore 315 and the second bore 317 being along the same axis, the first axis Y. Put another way, the first axis Y and the second axis X (not shown) are aligned. This particular force translator 310 may be useful in an injection

mold, for example, where it is desired to translate a force between movable members that fall along the same axis but are spaced apart.

With reference to the force translator 410 of FIG. 4C, it may be appreciated that the first axis Y and the second axis X of the first bore 415 and the second bore 417, respectively, are mutually inclined. For example, and without specific limitation, the first axis Y and the second axis X may be mutually inclined by about 15 degrees. This particular force translator 410 may be useful in an injection mold, for example, where it is desired to translate a force between movable members along axes that are mutually inclined to one another.

With reference to FIG. 4D, it may be appreciated that the first axis Y and the second axis X of the first bore 515 and the second bore 517, respectively, are substantially parallel but offset by a distance, and wherein the space 519 between them is defined by an S-shaped channel. This particular force translator 510 may be useful in an injection mold, for example, where it is desired to translate a force between movable members along axes that are parallel but spaced apart (i.e. offset).

With reference to FIG. 4E, which is similar to the preceding embodiment of FIG. 4D, it may be appreciated that the first axis Y and the second axis X of the first bore 615 and the second bore 617, respectively, are substantially parallel but offset by a distance, and wherein the space 619 between them is defined by an C-shaped channel. This particular force translator may be useful in an injection mold, for example, where it is desired to translate a force between movable members along axes that are parallel but spaced apart (i.e. offset), and moreover where it is desired to have the second engager 616 move in a direction that is opposite to that of the first engager 614.

In accordance with another alternative embodiment, not shown, the force translator, such as one or more of the force translators 210, 310, 410, 510 or 610, could be configured to include multiple second engagers (not shown) and in this way translate the motion of the first movable mold member to several other movable mold members.

As previously mentioned, the applicability of the linkage assembly 206, 306, 406, 506 and 606 within an injection mold (not shown) is not particularly limited but does find particular utility when adapted for use in ejecting molded article (not shown) from the injection mold.

It is these adaptations of the linkage assembly 206 that will be the subject matter of the remainder of the description.

Reference shall now be made to FIG. 5A that depicts a first mold portion 204 of an injection mold 202. The first mold portion 204 broadly includes a core assembly 240 as well as a stripper assembly 250. The foregoing core assembly 240 and the stripper assembly 250 are similar to those described earlier herein. The only notable difference between the two is the replacement of the linkage assembly for actuating a pair of slide 254 that are associated with the stripper assembly 250. More particularly the linkage assembly including the cam 156 (FIG. 2) has been replaced by a pair of the linkage assemblies 206. While not a prerequisite, providing a pair of linkage assemblies 206 acting with a top and bottom of the pair of slide 254 provides a more balanced application of force thereto. It is also worthwhile noting that the first mold portion 204 includes multiple pairs of the slide 254, four being depicted, and that these are respectively interconnected with a pair of connecting bars 258 so that the pair of the linkage assemblies 206 is able to operate them all.

With reference to FIGS. 5A and 5B it may be noted that the pair of linkage assemblies 206 are located, without particular limitation, within a corresponding pair of pockets 243, 257 that are formed through a core plate 242 of the core assembly 240 and a stripper plate 252 of the stripper assembly 250 adjacent to a top and a bottom thereof.

Reference shall now be made to the section view FIG. 6A that readily depicts the structure of one of the pair of linkage assemblies 206 and the manner in which it has been integrated within the first mold portion 204. Of note, the linkage assembly 206 selected includes the force translator 210 of FIG. 4A.

From this view it may be appreciated that the link body 212 of the force translator 210 has been arranged within the core plate 242 such that the first axis Y thereof is arranged parallel to a mold-stroke axis (not shown) of the first mold portion 204 (i.e. the direction along which the injection mold opens and closes), whereas the second axis X thereof is perpendicular thereto. While it is convenient for sake of assembly of the first mold portion 204 to provide the force translator 210 with a distinct link body 212 for installation into the core plate 242, as an alternative the first bore 215 (FIG. 4A & 6C) and the second bore 217 (FIG. 4A & 6C) could instead be formed directly in the core plate 242 (i.e. a portion of the

core plate 242 provides the link body). That being said, it may also be appreciated that a portion of the link body 212 also projects into an engager bore 253 that is formed through a back face of the stripper plate 252 of the stripper assembly 250. With the link body 212 so arranged, an engager extension 218 that is associated with the first engager 214 is able to engage a bottom face of the engager bore 253 for coordinating movement of the first engager 214 with movement of the stripper assembly 250 as will be more fully explained with reference to an operational description that follows. Also shown is a guide 213 that is associated with the link body 212 for guiding movement of the engager extension 218.

One may also readily appreciate that structure of the linkage assembly 206 includes a slide link 220. Broadly speaking, the slide link 220 is configured to link the second engager 216 of the force translator 210 with the pair of slides 254. The slide link 220 broadly includes a bracket 224 as well as a slide engager 228. The bracket 224 is configured to be slidably supported in the core plate 242 of the core assembly 240 to accommodate relative movement thereof along the second axis X as well as to engage the second engager 216 to provide for movement thereof relative to the core assembly 240. The slide engager 228 is configured to be supported by the stripper assembly 250 to accommodate coordinated movement therewith, with the relative movement of the stripper assembly 250 and the core assembly 240 along the mold-stroke axis. In addition, the slide engager 228 is configured to engage the pair of slides 254 to provide for the relative movement thereof.

As best shown with reference to Figure 6C, the bracket 224 is made from two parts wherein a lower portion thereof is provided in a lower body 230 and likewise an upper portion thereof is provided in an upper body 232. The lower body 230 is generally cylindrical in shape, whereas the upper body is shaped like a block, and wherein the lower body 230 is arranged to pass through the upper body 232 and to be generally fixed in relation thereto by a spring clip 251. Of course, the upper and lower portions of the bracket could instead be made from a single contiguous body.

The bracket 224 and the slide engager 228 are further configured to cooperate together, wherein the slide engager 228 is slidably supported by the bracket 224 for coordinated movement therewith along the second axis X and further wherein the slide engager 228 is movable relative to the bracket 224 along a third axis Y'. In this way, the slide engager 228 is movable with the bracket 224, along the second axis X, for reasons that will be apparent shortly, and yet movable relative to the bracket 224, along the third axis Y', to

accommodate the relative movement between the stripper assembly 250 and the core assembly 240. The foregoing is accomplished by providing a main body 260 of the slide engager 228 with a pair of slide pins 247 depending therefrom that are slidably engageable within a pair of slide bores 246 that are defined in the upper body 232 of the bracket 224. It may also be noted that the bracket 224 includes a pad 261 (FIG. 6A) on the side thereof, there being a similar pad on the opposite side of the bracket 224. The pads cooperate together with sides of the pocket 257 (FIG. 5A) in the stripper plate 252 to self-align the slide engager 228.

The slide link 220 is also shown to include a guide member 226 for guiding movement of the bracket 224 relative to the core plate 142 along the second axis X. The structure of the guide member 226 is best revealed with reference to FIG. 6B, wherein it may be appreciated that the guide member 226 broadly includes a guide sleeve 238, tubular in shape, that is fixed relative to the core plate 242 and a guide bore 234 defined in the bracket 224. The guide sleeve 238 and the guide bore 234 are configured to cooperate in guiding movement of the bracket 224 along the second axis X. The guide member 226 also includes a shoulder retainer 241 that is fixed to the bracket 224 with a head portion thereof being arranged within the guide sleeve 238 to provide an inner position limit to the relative movement between the guide sleeve 238 and the bracket 224, along the second axis X, in cooperation with a flange 245 (FIG. 6C) that is defined within the guide sleeve 238, the foregoing being illustrated with further reference to FIG. 6D. Lastly, it may be appreciated that a head 244 at an end of the guide sleeve 238 is structured to provide an outer position limit to the relative movement between the guide sleeve 238 and the bracket 224 in cooperation with an end face 225 (FIG. 6D) of the bracket 224, the foregoing being illustrated with further reference to FIG. 6C.

With reference back to FIG. 6A, it may be further appreciated that the slide link 220 also includes a biasing structure 222 (e.g. coil spring, air spring, elastomer spring, etc.) that is arranged in the guide bore 234 of the bracket 224 between a bottom face thereof and the flange 245 within the guide sleeve 238, whereby the slide link 220 is biased towards the outer position limit.

Furthermore, it may be seen that the slide engager 228 includes a cam 248 that defines a pair of cam profiles 249 with which to engage respective cam followers 255 (FIG. 6B) that are associated with the pair of slides 254, wherein relative motion between the pair of

slides 254 is governed by relative motion between the cam 248 and the cam follower 255. The pair of cam followers 255 may be mounted directly to the pair of slides 254, as shown, or may be mounted indirectly via connecting bars 258 and the like.

Lastly, the stripper assembly 250 may include a slide biasing member (not shown) that is arranged between each of the pairs of slides 254 to bias them away from each other (i.e. towards an ejection configuration) wherein they are spaced apart, and further wherein the pair of slides 254 are closed again to a molding configuration through interaction of the cam 248 and the pair of cam followers that are associated with the pair of slides 254.

The operation of the linkage assembly 206 will now be discussed with reference to FIGS. 6C and 6D that depict the linkage assembly 206 in a first operating configuration and a second operating configuration, respectively. The linkage assembly 206 is arranged in the first operating configuration for closing the pair of slides 254 on the stripper assembly 250 (not shown), and conversely in the second operating configuration for opening of the pair of slides 254.

Broadly speaking, the operation of the linkage assembly 206 within the context of the overall molding process includes the following steps:

- Retracting the stripper assembly 250 into the molding configuration and in so doing causing the first engager 214 to retract (FIG. 6C). The retraction of the first engager 214 in turn causes second engager 216 to extend and in so doing positions the slide engager 228 such that the cam 248 cooperates with the cam follower 255 to move the pair of slides 254 to their closed position (i.e. molding configuration).
- Closing the injection mold 202.
- Molding of a molded article (not shown) therein.
- Opening of the injection mold.
- Extending the stripper assembly 250 into the ejection configuration (not shown) and in so doing allowing the first engager 214 freedom of movement to extend (FIG. 6D). Actual movement of the first engager 214 is caused the biasing member 222 acting on the second engager 216. That is, retraction of the second engager 216 in turn causes first engager 214 to extend as governed by the position of the stripper assembly 250. With retraction of the second engager 216 the slide engager 228 is also moved to re-position the cam 248 relative to the cam

follower 255 and in so doing allowing the pair of slides 254 to move to their open position (i.e. ejection configuration) under the influence of the biasing member that is disposed therebetween.

- With ejection of the molded article the process can then be repeated.

More specifically, in the first operating configuration, FIG. 6C, the engager extension 218 is held in its lower position within the link body 212 through interaction with the engager bore 253 (FIG. 6A) of the stripper plate 252 (FIG. 6A) of the stripper assembly 250 that is positioned in a molding configuration. With the engager extension 218 being in its lower position, along the first axis Y, the first engager 214 is held in its lower position. The force translator 210 in turn has positioned the second engager 216, along the second axis X, into its extended position (i.e. outer limit of travel). With the second engager 216 being in its extended position the bracket 224 is in turn held in its extended position, along the second axis X, by virtue of being engaged therewith. By virtue of the guide sleeve 238 being fixed in the core plate 242 (FIG. 6A) and the bracket 224 being in the extended position, the biasing member 222 is in a compressed state within the guide bore 234. By virtue of the stripper assembly 250 (FIG. 6A) being arranged in the molding configuration the slide engager 228 is arranged in a lower position, along the third axis Y', relative to the bracket 224. In this configuration, the cam 248 is positioned such that a wide portion 249A of the cam profile 249 is in contact with the cam follower 255 and in this manner holds the associated slide of the pair of slides 254 in a closed position. While not shown, the mirror cam profile on the opposite side of the cam 248 contacts a different cam follower of an adjacent pair of slides in a similar manner. Lastly, by virtue of the interconnection between respective slides of the multiple pairs of slides, with the connecting bars 258, the remaining slides are all similarly arranged in their respective closed positions.

In the second operating configuration, FIG. 6D, the engager extension 218 is in its extended position, along the first axis Y, through interaction with the engager bore 253 (FIG. 6A) of the stripper plate 252 (FIG. 6A) which have been positioned in an ejection configuration (i.e. spaced apart from the core assembly 240 along the mold stroke axis) and through the action of the force translator 210 under the influence of the biasing member 222. More particularly, the biasing member 222 has acted upon the fixed guide sleeve 238 and the movable bracket 224 to position the bracket 224, along the second axis X, towards the force translator 210 and in so doing has pushed the second engager 216 towards its retracted position (i.e. inner limit of travel) within the link body 212 which in turn causes

the first engager 214 to extend along the first axis Y. Furthermore, by virtue of the stripper assembly 250 (FIG. 6A) being arranged in the ejection configuration the slide engager 228 is arranged in its upper position, along the third axis Y', relative to the bracket 224. In this configuration, the cam 248 is positioned such that a narrow portion 249C of the cam profile 249 is in contact with the cam follower 255 and in this manner has allowed the associated slide of the pair of slides 254 to move to a position under the influence of the slide biasing member (not shown). As explained previously, not shown, the mirror cam profile on the opposite side of the cam 248 contacts the different cam follower of the adjacent pair of slides in a similar manner.

While not illustrated, as the linkage assembly 206 transitions between the operating configurations (i.e. the first operating configuration and the second operating configuration) the cam followers 255 follow a transition portion 249B of the cam profile 249 that joins the wide portion 249A with the narrow transition portion 249B of the cam profile 249. As such, a closing force that is required to close the pairs of slides 254 is generated by the cam follower 255 in cooperation with the transition portion 249B. In contrast with the cam profiles of the prior art, the transition portion 249B may be aggressively sloped. Without particular limitation, the cam profile 249 may be selected such that the pairs of slides are not opened until the stripper assembly 250 has neared the end of its ejection stroke. In this way, the associated split mold inserts 184 (FIG. 2) are able to hold onto the molded articles (not shown) throughout a substantial portion of the ejection stroke, releasing them only at the very end. A technical effect of the foregoing may include improved transfer of the molded articles to a post-mold receptacle such as a cooling tube on an end-of-arm tool (not shown).

Other technical effects of the foregoing linkage assembly relative to those of the prior art may include one or more of relatively high speed ejector motion, independent slide opening, simpler overall construction (i.e. fewer parts in the system). Optimized cam profile for a broad array of molded articles, leads to reduced operator influence.

It is noted that the foregoing has outlined some of the more pertinent non-limiting embodiments. It will be clear to those skilled in the art that modifications to the disclosed non-embodiment(s) can be effected without departing from the spirit and scope thereof. As such, the described non-limiting embodiment(s) ought to be considered to be merely illustrative of some of the more prominent features and applications. Other beneficial

results can be realized by applying the non-limiting embodiments in a different manner or modifying the invention in ways known to those familiar with the art. This includes the mixing and matching of features, elements and/or functions between various non-limiting embodiment(s) is expressly contemplated herein so that one of ordinary skill in the art would appreciate from this disclosure that features, elements and/or functions of one embodiment may be incorporated into another embodiment as skill in the art would appreciate from this disclosure that features, elements and/or functions of one embodiment may be incorporated into another embodiment as appropriate, unless described otherwise, above. Although the description is made for particular arrangements and methods, the intent and concept thereof may be suitable and applicable to other arrangements and applications.

WHAT IS CLAIMED IS:

1. A linkage assembly (206, 306, 406, 506, 606) for use with an injection mold (202), the linkage assembly (206, 306, 406, 506, 606), comprising:
 - a force translator (210, 310, 410, 510, 610) having a first engager (214, 314, 414, 514, 614) and a second engager (216, 316, 416, 516, 616), wherein the first engager (214, 314, 414, 514, 614) and the second engager (216, 316, 416, 516, 616) are connected by a medium for coordinated movement thereof.
2. The linkage assembly (206, 306, 406, 506, 606) of claim 1, wherein:
 - the first engager (214, 314, 414, 514, 614) being configured to engage a first movable mold member;
 - the second engager (216, 316, 416, 516, 616) being configured to engage a second movable mold member.
3. The linkage assembly (206, 306, 406, 506, 606) of claim 1, wherein:
 - the medium is one of:
 - hydraulic fluid;
 - a plurality of solid bodies;
 - a plurality of bearing balls;
 - a gas; or
 - a body made from a natural rubber.
4. The linkage assembly (206, 306, 406, 506, 606) of claim 2, further comprising:
 - a biasing member (222) for biasing movement of the first engager (214, 314, 414, 514, 614) and the second engager (216, 316, 416, 516, 616).
5. The linkage assembly (206, 306, 406, 506, 606) of claim 4, wherein:
 - the force translator (210, 310, 410, 510, 610) further includes a link body (212, 312, 412, 512, 612) that defines a first bore (215, 315, 415, 515, 615) and a second bore (217, 317, 417, 517, 617);
 - the first bore (215, 315, 415, 515, 615) and the first engager (214, 314, 414, 514, 614) being configured to cooperate such that the first engager (214, 314, 414, 514, 614) is slidable within the first bore (215, 315, 415, 515, 615) along a first axis (Y);

the second bore (217, 317, 417, 517, 617) and the second engager (216, 316, 416, 516, 616) being configured to cooperate such that the second engager (216, 316, 416, 516, 616) is slidable within the second bore (217, 317, 417, 517, 617) along a second axis (X);

the first bore (215, 315, 415, 515, 615) and the second bore (217, 317, 417, 517, 617) being connected to define a space (219, 319, 419, 519, 619) between the first engager (214, 314, 414, 514, 614) and the second engager (216, 316, 416, 516, 616) within which to arrange the medium.

6. The linkage assembly (206, 306, 406, 506, 606) of claim 5, wherein:
the first axis (Y) and the second axis (X) are parallel.
7. The linkage assembly (206, 306, 406, 506, 606) of claim 6, wherein:
the first axis (Y) and the second axis (X) are one or aligned or offset relative to each other.
8. The linkage assembly (206, 306, 406, 506, 606) of claim 5, wherein:
the first axis (Y) and the second axis (X) are mutually inclined.
9. The linkage assembly (206, 306, 406, 506, 606) of claim 5, wherein:
the link body (212, 312, 412, 512, 612) is configured to be associated with a core assembly (240) of a first mold portion (204) of the injection mold (202);
the first movable mold member is a stripper assembly (250) of the first mold portion (204); and
the second movable mold member is a pair of slides (254) that are associated with the stripper assembly (250).
10. The linkage assembly (206) of claim 9, further comprising:
a slide link (220) that is configured to link the second engager (217) with the pair of slides (254).
11. The linkage assembly (206) of claim 10, wherein:
the slide link (220) includes a bracket (224) and a slide engager (228); and wherein:
the bracket (224) being configured:
to be slidably supported in the core assembly (240) to accommodate relative movement thereof along the second axis (X); and

to engage the second engager (216) to provide for movement thereof relative to the core assembly (240);

the slide engager (228) being configured:

to be supported by the stripper assembly (250) to accommodate coordinated movement therewith with the relative movement of the stripper assembly (250) and the core assembly (240); and

to engage the pair of slides (254) to provide for the relative movement thereof.

12. The linkage assembly (206) of claim 11, wherein:

the bracket (224) and the slide engager (228) being further configured to cooperate, wherein the slide engager (228) is slidably supported by the bracket (224) for coordinated movement therewith along the second axis (X) and further wherein the slide engager (228) is movable relative to the bracket (224) along a third axis (Y'), whereby the slide engager (228) is movable with the bracket (224), along the second axis (X), and movable relative to the bracket (224), along the third axis (Y'), to accommodate the relative movement between the stripper assembly (250) and the core assembly (240).

13. The linkage assembly (206) of claim 12, further comprising:

a guide member (226), wherein the bracket (224) and the guide member (226) are configured to cooperate in guiding movement of the bracket (224) relative to a core plate (142) of the core assembly (240).

14. The linkage assembly (206) of claim 13, wherein:

the guide member (226) includes a guide sleeve (238), a shoulder retainer (241), and a guide bore (234) defined in the bracket (224);

the guide sleeve (238) being configured to be fixed to the core plate (142);

the guide sleeve (238) and the guide bore (234) are configured to cooperate in guiding movement of the bracket (224) along the second axis (X).

the shoulder retainer (241) being configured to be fixed to the bracket (224) with a head portion thereof being arranged within the guide sleeve (238) to provide an inner position limit to the relative movement between the guide sleeve (238) and the bracket (224) in cooperation with a flange (245) within the guide sleeve (238);

a head (244) being defined at an end of the guide sleeve (238) that provide an outer position limit to the relative movement between the guide sleeve (238) and the bracket (224) in cooperation with an end face (225) of the bracket (224).

15. The linkage assembly (206) of claim 14, wherein:

the slide link (220) further includes a biasing structure (222) that is arranged in the guide bore (234) between a bottom face thereof and the flange (245) within the guide sleeve (238), whereby the slide link (220) is biased towards the outer position limit.

16. The linkage assembly (206) of claim 12, wherein:

the slide engager (228) includes a cam (248) that defines a cam profile (249) with which to engage a cam follower (255) that is associated with one of the pair of slides (254), wherein relative motion between the pair of slides (254) is provided with the relative motion between the cam (248) and the cam follower (255).

17. The linkage assembly (206) of claim 16, wherein:

the cam (248) defines a pair of cam profiles with which to engage a pair of cam followers that are associated with the pair of slides (254), respectively, wherein the relative motion between the pair of slides (254) is governed by the cam (248) in cooperation with the pair of cam followers (255).

18. The linkage assembly (206) of claim 17, wherein:

a slide biasing member is arranged between the pair of slides (254) to bias them away from each other which is towards an ejection configuration, wherein they are spaced apart, and further wherein the pair of slides (254) are closed again to a molding configuration through interaction of the cam (248) and the pair of cam followers that are associated with the pair of slides (254).

19. A slide engager (228), comprising:

a main body (260) that is configured to be supported by a stripper assembly (250) of an injection mold (202); and

a cam (248) that is associated with the main body (260), the cam (248) defines a cam profile (249) with which to engage a cam follower (255) that is associated with one of a pair of slides (254) that are associated with the stripper assembly (250), wherein relative motion between the pair of slides (254) is provided with the relative motion between the cam (248) and the cam follower (255).

20. The slide engager (228) of claim 19, wherein:

the slide engager (228) being further configured to cooperate, in use, with a bracket (224) of a slide link (220), wherein the slide engager (228) is slidably supported by the bracket (224) for coordinated movement therewith along a second axis (X) and further wherein the slide engager (228) is movable relative to the bracket (224) along a third axis (Y'), whereby the slide engager (228) is movable with the bracket (224), along the second axis (X), and movable relative to the bracket (224), along the third axis (Y'), to accommodate a relative movement between the stripper assembly (250) and a core assembly (240) of the injection mold (202).

21. The slide engager (228) of claim 19, wherein:

the cam (248) defines a pair of cam profiles with which to engage a pair of cam followers that are associated with the pair of slides (254), respectively, wherein the relative motion between the pair of slides (254) is governed by the cam (248) in cooperation with the pair of cam followers (255).

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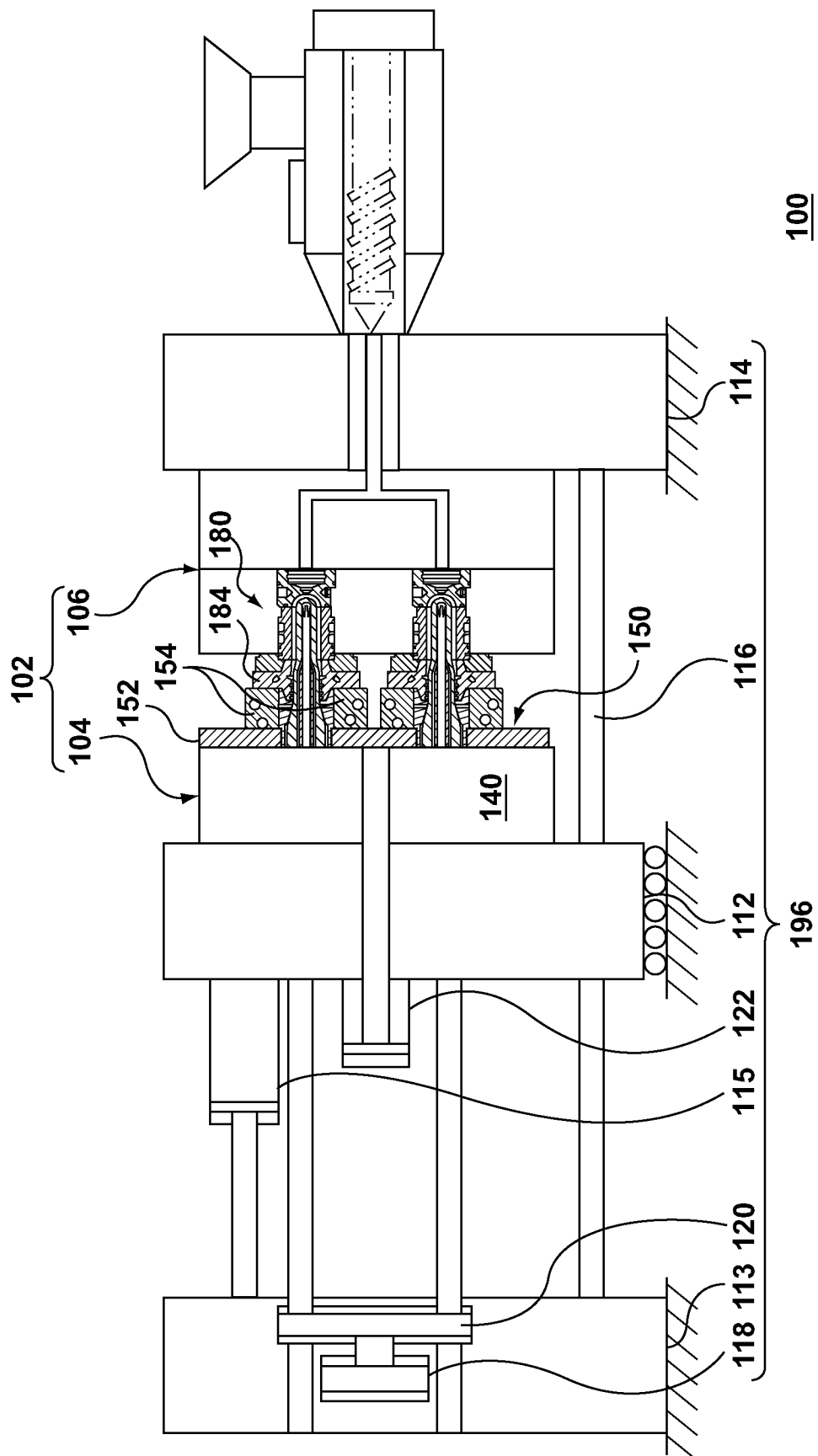


FIG. 1 (PRIOR ART)

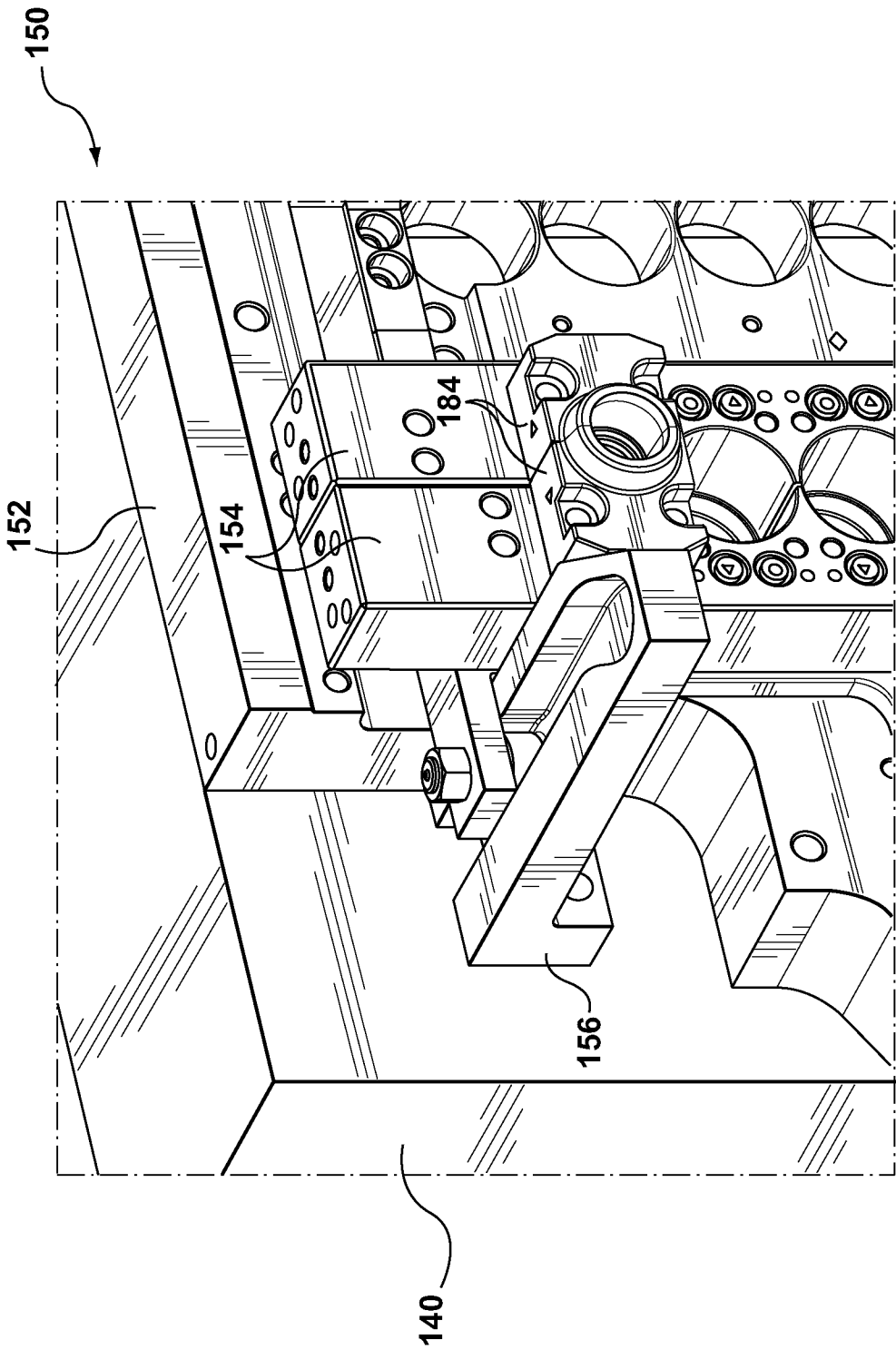


FIG. 2 (PRIOR ART)

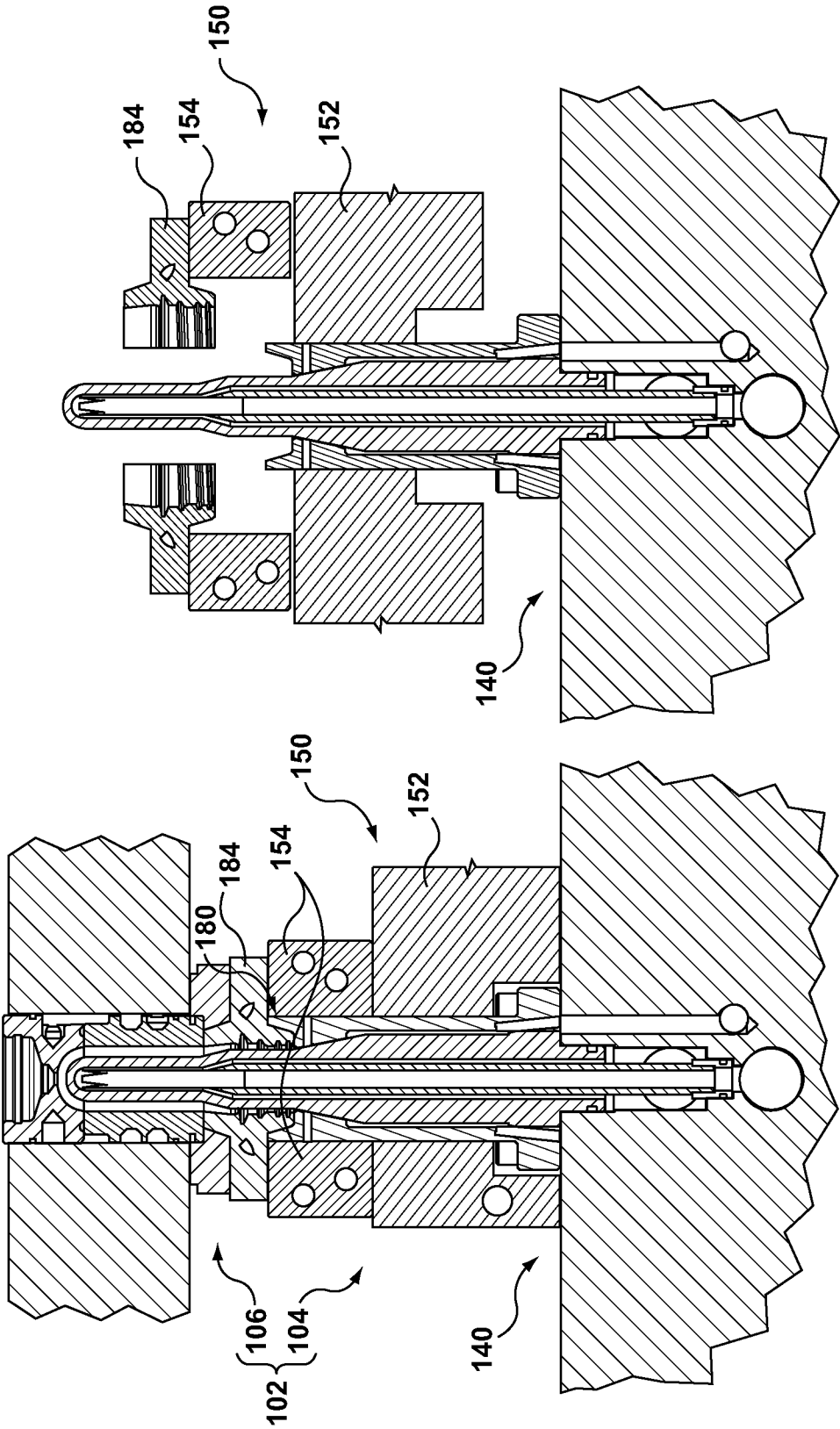
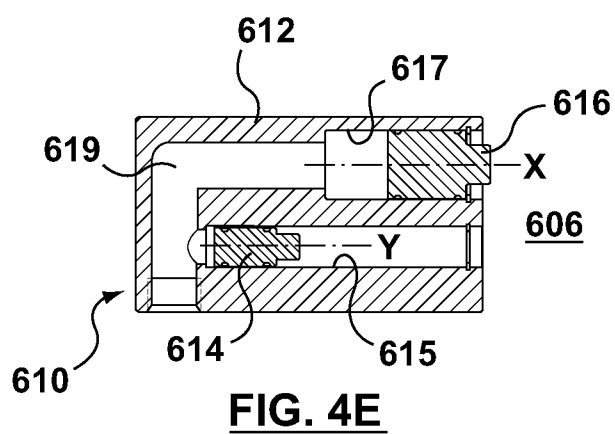
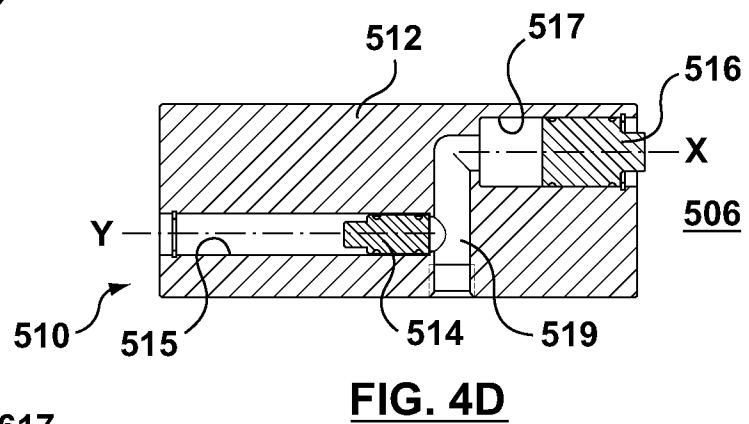
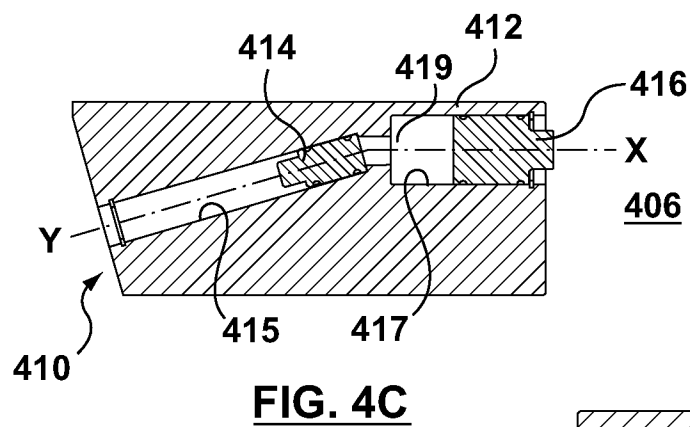
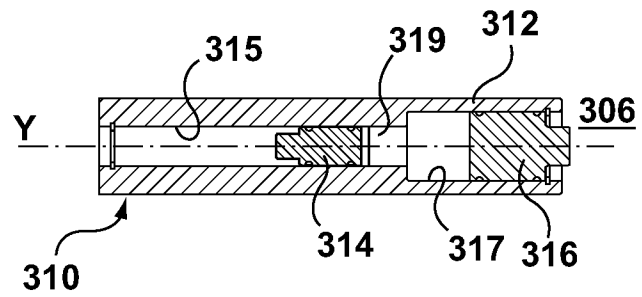
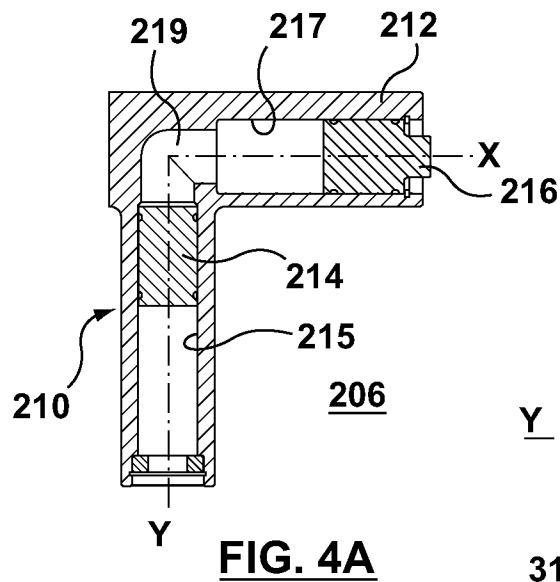


FIG. 3B (PRIOR ART)

FIG. 3A (PRIOR ART)

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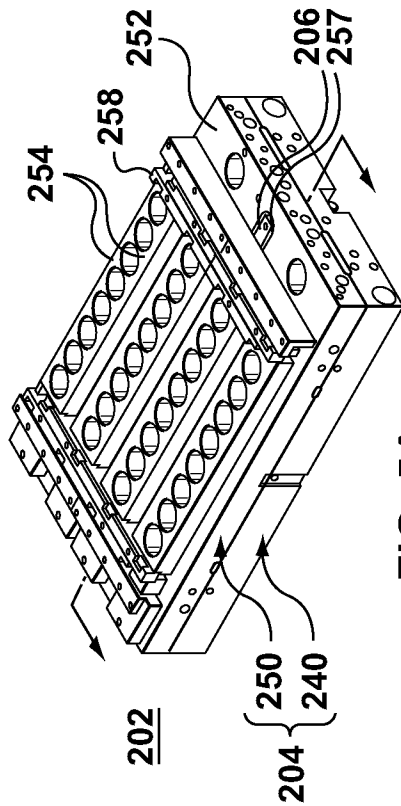


FIG. 5A

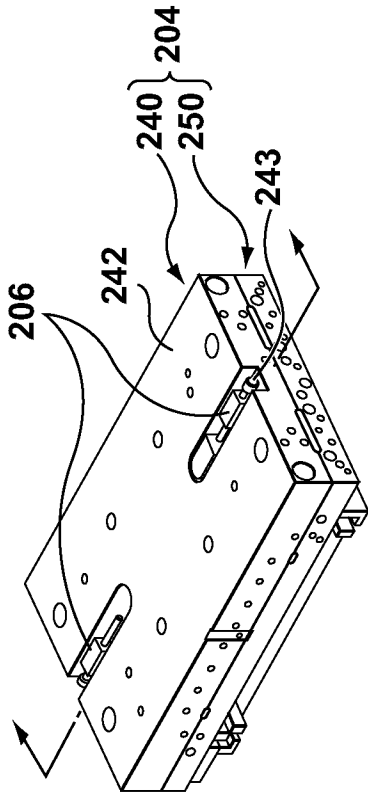


FIG. 5B

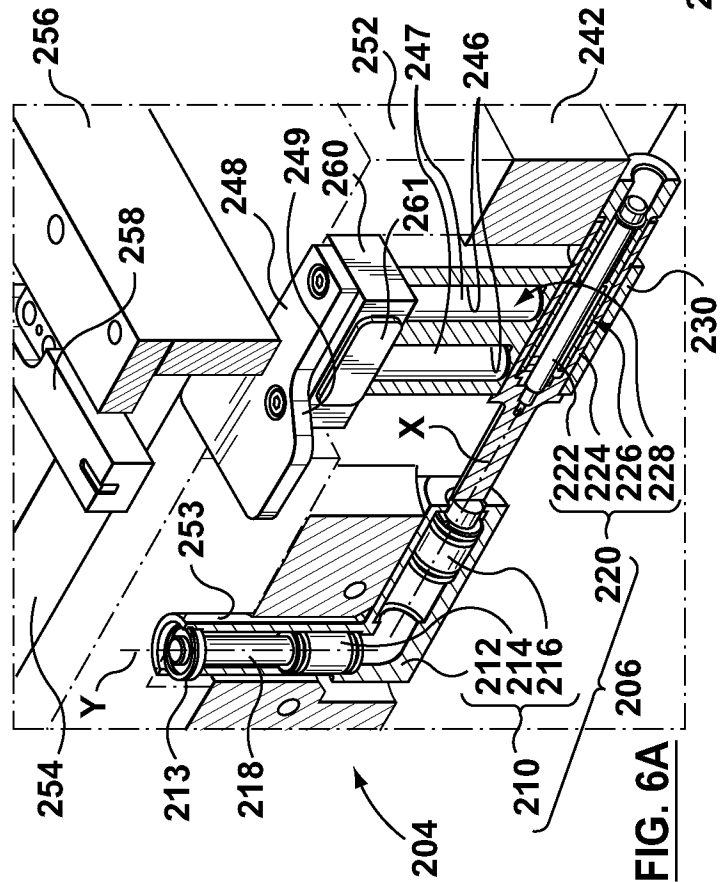


FIG. 6A

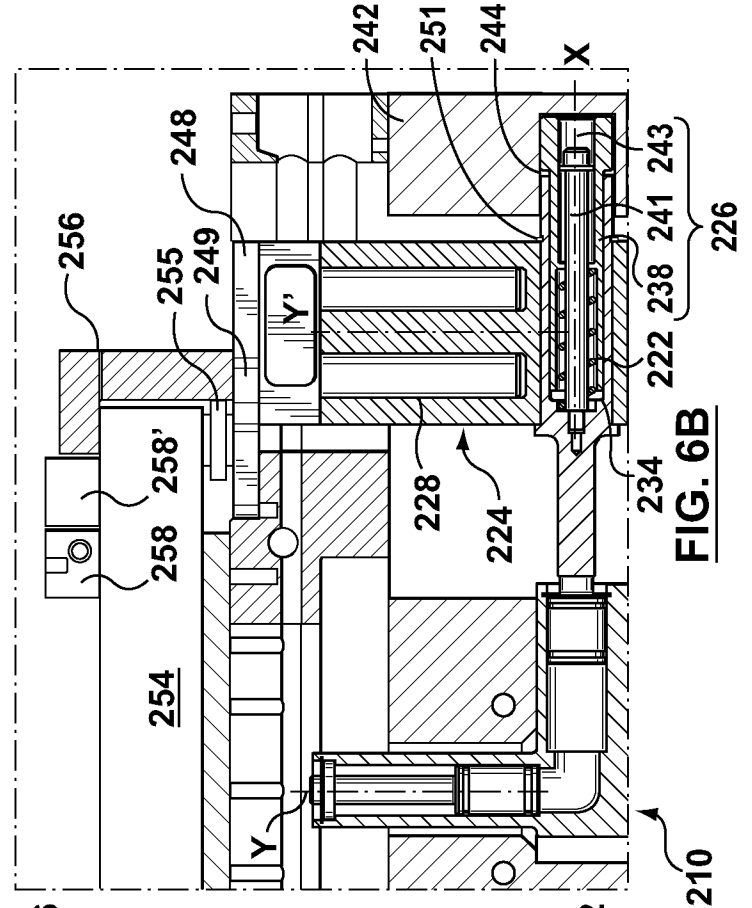


FIG. 6B

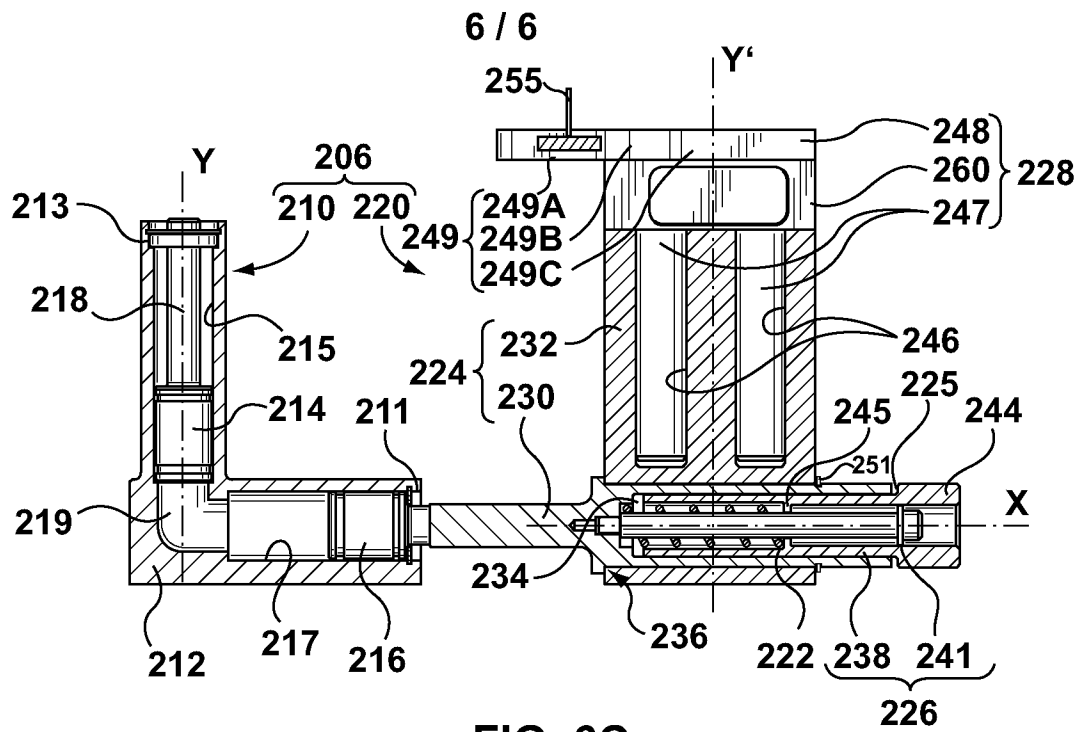


FIG. 6C

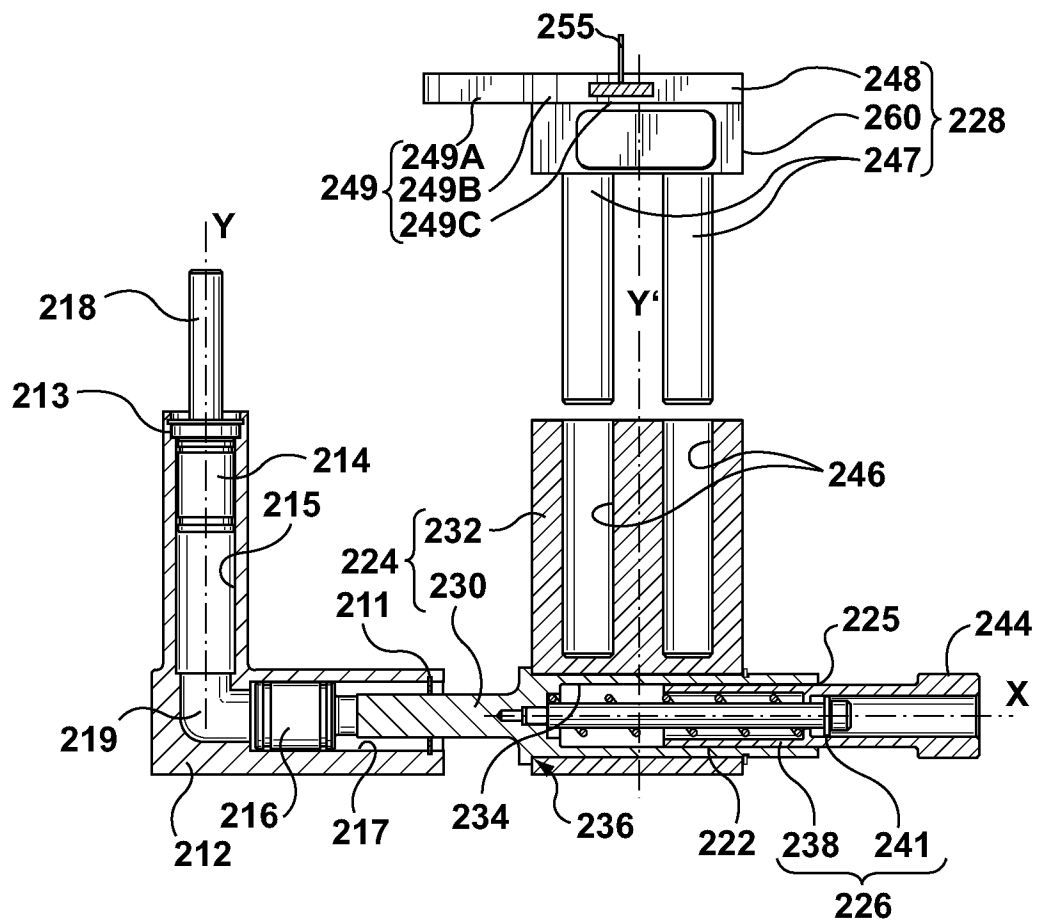


FIG. 6D

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2012/050317

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **B29C 45/26** (2006.01) , **B29C 45/17** (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 45/*** (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)
EPOQUE (EPODOC and X-FULL), CPD with key words, such as: mold, mould, first/second piston, first/second cylinder, medium, fluid, first/second engag*, first/second driv*, cam and follower.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4128380 A (JAMANN, H.) 5 December 1978 (5-12-1978) *whole document*	1-18
A	US 3805577 A (BERGEMANN, W. E. et al.) 23 April 1-74 (23-04-1974) *cited by applicant* *whole document*	1-18
A	US 6767497 B2 (KNEPPER, et al.) 27 July 2004 (27-07-2004) *whole document*	19-21

☐ 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

18 June 2012 (18-06-2012)

Date of mailing of the international search report

20 June 2012 (20-06-2012)

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 REPORTInternational application No.
PCT/CA2012/050317**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons :

1. ☐ Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :
2. ☐ Claim Nos. :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically :
3. ☐ Claim Nos. :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows :

Group A - Claims 1-18 are directed to a linkage assembly having a force translator with two engagers, wherein two engagers are connected by a medium; and

Group B - Claims 19-21 are directed to a cam-follower structure.

According to subsection 36(2) of the Patent Act, after limiting the claims of the present application to one invention only, the applicant may

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos. :
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos. :

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2012/050317

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		CH576823A5	30 June 1976 (30-06-1976)
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		FR2206185B1	26 January 1979 (26-01-1979)
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		IT992936B	30 September 1975 (30-09-1975)
		JP49078759A	30 July 1974 (30-07-1974)
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		JP1118630C	28 October 1982 (28-10-1982)
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		SE398451C	06 April 1978 (06-04-1978)
		ZA7305381A	26 March 1975 (26-03-1975)
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		CA2408058A1	20 May 2003 (20-05-2003)
		CA2408058C	18 March 2008 (18-03-2008)
		DE60233376D1	01 October 2009 (01-10-2009)
		EP1312457A1	21 May 2003 (21-05-2003)
		EP1312457B1	19 August 2009 (19-08-2009)
		MXPA02010157A	14 October 2004 (14-10-2004)
		US2003094733A1	22 May 2003 (22-05-2003)