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(54) Title: MOLDING APPARATUS AND MOLDING PROCESS

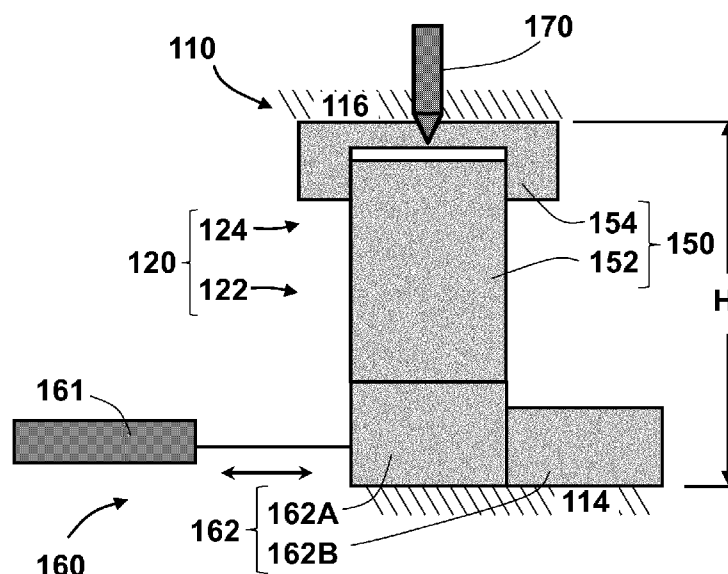


FIG. 1

(57) Abstract: Disclosed herein, amongst other things, is a molding process (800) that includes maintaining (810) opposing platens of a mold clamp (110, 210, 310) at a shut height (H) that is kept substantially constant while performing the further operations of: holding (820) relatively moveable parts of a mold (120, 220, 320, 420) that is positioned between the opposing platens of the mold clamp (110, 210, 310) in a sequence of discrete molding configurations; molding (830) a molded article (180, 280, 380, 480, 580) in a sequence of molding operations in the discrete molding configurations; and ejecting (840) the molded article (180, 280, 380, 480, 580) from the mold (120, 220, 320, 420).





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MOLDING APPARATUS AND MOLDING PROCESS

TECHNICAL FIELD

5 Non-Limiting embodiments disclosed herein generally relate to a molding apparatus and a molding process involving the use thereof.

SUMMARY

10 In accordance with an aspect disclosed herein, there is provided a molding process that includes maintaining opposing platens of a mold clamp at a shut height that is kept substantially constant while performing the further operations of holding relatively moveable parts of a mold that is positioned between the opposing platens of the mold clamp in a sequence of discrete molding configurations; molding a molded article with a sequence of molding operations in the
15 discrete molding configurations; and ejecting the molded article from the mold.

In accordance with a further aspect disclosed herein, there is provided a computer program product storing computer readable instructions for execution by a controller of a molding system for performing the molding process.

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In accordance with another aspect disclosed herein, there is provided a molding apparatus. The molding apparatus includes a holder that is selectively configurable into a plurality of holding configurations to hold relatively moveable parts of a mold in a sequence of discrete molding configurations with the mold positioned between opposing platens of a mold clamp that are
25 maintained at a shut height that is kept substantially constant, whereby a sequence of molding operations may be performed in the discrete molding configurations to mold a molded article.

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
30 embodiments in conjunction with the accompanying drawings.

DETAILED DESCRIPTION OF THE DRAWINGS

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

FIG. 1 depicts a non-limiting schematic representation of a mold and holder arranged in a mold clamp;

5 FIGS. 2A-2E depict a schematic operating sequence of the mold and holder of FIG. 1 that illustrate a non-limiting embodiment of a molding process;

FIGS. 3A-3C depict a schematic operating sequence of a molding system including a mold and holder of another non-limiting embodiment that illustrate a further non-limiting embodiment of
10 the molding process;

FIGS. 4A-4C depict a schematic operating sequence of a mold and a pair of holders in accordance with a further non-limiting embodiment that further illustrate an alternative non-limiting embodiment of the molding process;

15 FIGS. 5A-5C depict a schematic operating sequence of a molding system including a mold and holder of another non-limiting embodiment that illustrate another alternative non-limiting embodiment of the molding process;

20 FIG. 6 depicts a schematic sequence of a holder in accordance with yet another alternative non-limiting embodiment;

FIGS. 7A-7E depict a schematic operating sequence of the mold of FIG. 4A that illustrates yet another alternative non-limiting embodiment of the molding process;

25 FIG. 8 depicts a side view of a preform of the type for blow molding into a container in accordance with a non-limiting embodiment;

FIG. 9 depicts a perspective view of a closure of the type for capping a neck finish of a
30 container in accordance with a non-limiting embodiment;

FIG. 10 depicts a flow chart of the molding process in accordance with a non-limiting embodiment.

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.

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DETAILED DESCRIPTION OF THE NON-LIMITING EMBODIMENT(S)

Reference will now be made in detail to various non-limiting embodiment(s) of a molding apparatus and a molding process involving the use thereof. It should be understood that other
10 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
15 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.

With reference to FIG. 1 there is depicted a non-limiting schematic embodiment of a mold
20 and a holder 160 that are positioned between opposing platens 114, 116 of a mold clamp 110.

The mold 120 broadly includes a first mold part 122 and a second mold part 124 that together define a molding cavity between relatively movable parts thereof. Specifically, the molding cavity is defined between a first stack part 152 and a second stack part 154 of a mold stack 150
25 that are associated with the first mold part 122 and the second mold part 124, respectively.

The holder 160 is arranged between the platen 114 and the first stack part 152 of the mold stack 150. As can be appreciated with further reference to FIGS. 2A-2E, the holder 160 is structured to be selectively configurable into a plurality of holding configurations to hold the relatively
30 moveable parts of the mold 120 in a sequence of discrete molding configurations even while the platens 114, 116 of the mold clamp 110 are maintained at a shut height H that is substantially constant. In so doing, a sequence of molding operations may be performed in the discrete molding configurations to mold a molded article 180 (FIG. 2E).

Referring back to FIG. 1, it can be appreciated that the holder 160 includes a mold support 162 and an actuator 161 for selectively positioning a selected one of a plurality of support surfaces 162A, 162B of different heights that are defined thereon between the platen 114 and the first stack part 152 to support the first stack part 152 in each of the discrete molding configurations.

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A non-limiting embodiment of a molding process 800 (FIG. 10) will now be described with reference to the sequence of FIGS. 2A-2E. The molding process includes maintaining 810 (FIG. 10) opposing platens of the mold clamp 110 at a shut height H that is kept substantially constant while performing the further operations listed hereafter. The further operations include

10 holding 820 (FIG. 10) the relatively moveable parts of the mold 120 in each of the sequence of discrete molding configurations while molding 830 (FIG. 10) the molded article 180 in a sequence of molding operations. The foregoing may be appreciated in greater detail beginning with reference to FIG. 2A wherein the relatively moveable parts of the mold 120 are being held in a first molding configuration (A) of the sequence of discrete molding configurations to

15 define a first molding cavity 158A therebetween. As can be seen the mold support 162 is positioned such that the taller support surface 162A is arranged beneath the first stack part 152. Next, with reference to FIG. 2B a first of the sequence of molding operations may be appreciated wherein a first molding material is injected into the first molding cavity 158A to mold a first part 180A of the molded article 180 (FIG. 2E). Next with reference to FIG. 2C it

20 may be appreciated that the relatively moveable parts of the mold 120 are next held in a second molding configuration (B) of the sequence of discrete molding configurations to define a second molding cavity 158B therebetween. In so doing, the mold support 162 has been repositioned such that the shorter support surface 162B is arranged beneath the first stack part 152. Next, with reference to FIG. 2D a second of the sequence of molding operations may be

25 appreciated wherein a second molding material (which may or may not be different than the first molding material) is injected into the second molding cavity 158B that includes the first part 180A of the molded article 180 to mold a second part 180B of the molded article 180 (FIG. 2E). The molding process 800 ends or repeats after a final operation of ejecting 840 (FIG. 10) the molded article 180 from the mold 120. As can be seen with reference to FIG. 2E, the

30 foregoing may include selectively configuring the holder 160 into a release configuration wherein the mold support 162 is withdrawn to a position beside the first stack part 152 such that it is effectively released for movement to an ejection configuration. In the ejection configuration the relatively moveable parts of the mold (i.e. first stack part 152 and the second stack part 154) are spaced apart, as shown, such that the mold article 180 may be removed from

35 therebetween.

A technical effect of the foregoing may include the ability to mold a molded article requiring multiple molding steps, such as, for example, those having multiple layers of molding material, substantially without having to move the opposing platens of the mold clamp. That being said, the foregoing does not preclude a small amount of movement between the opposing platens of the mold clamp 110 such as, for example, that which may result from cycling a clamping force being applied to the mold 120 between molding operations of the sequence of molding operations. That is, it may be required in some instances to reduce or remove the clamping force prior to selectively configuring the holder into different holding configurations.

Reference shall now be made to FIGS. 3A-3C that depict a schematic operating sequence of a molding system 200 performing another non-limiting embodiment of the molding process 800 (FIG. 10). The molding system 200 is fairly typical in that it includes a mold clamp 210, for clamping a mold 220 between opposing platens 214, 216 thereof, and a pair of injection units 212, 213 for preparing and injecting molding materials into a mold 220 via a melt distributor 230 (e.g. hot runner) that is associated with the mold 220. A detailed description of the foregoing components has been omitted as the structure and operation thereof is consistent with the state of the art as is well known to the skilled person.

The mold 220 includes a first mold part 222 and a second mold part 224 that are associated with opposite platens 214, 216 of the mold clamp 210. Relatively moveable parts of a mold stack 250 (or a plurality thereof – not shown) are associated with the parts of the mold 120 with which to define a molding cavity therebetween and to release a molded article therefrom. Specifically, the mold stack 250 includes a first stack part 252 and a second stack part 254 that are associated with the first mold part 222 and the second mold part 254, respectively. In this non-limiting embodiment, the first stack part 252 includes a core member 255 and the second stack part 254 defines a cavity. The first mold part 222 also includes a mold cassette 240 that is contained, in part, within an ejector box 242 of the first mold part 222. The mold cassette 240 includes a core group 244 on which the core member 255 is associated. The core group 244 includes a retainer plate onto which the core member 255 is attached. Additional mold cores of further mold stacks, not shown, could be similarly attached thereto and in this way be moved in tandem. The core group 244 is selectively positionable relative to the second mold part 224 by means of an actuator 218, governed by a controller 266. In so doing, the core member 255 that is associated with the core group 244 may be selectively positioned between a sequence of discrete molding configurations within the cavity of the second stack part 254. The foregoing

may be appreciated by contrasting FIGS. 3A and 3B, wherein the core group 244 is selectively positioned by the actuator 218 such that the core member 255 of the first stack part 252 and the cavity of the second stack part 254 are first configured in a first molding configuration to define a first molding cavity 258A therebetween and then into a second molding configuration to define a second molding cavity 258B therebetween. Similarly, the core group 244 may be positioned into an ejection configuration, as shown with reference to FIG. 3C, wherein the first stack part 252 and the second stack part 254 are separated such that a molded article 280 may be ejected therefrom for removal from the mold 220 in a space defined between the ejector box 242 and the second mold part 224. Removal of the molded part 280 may be assisted by an in-mold part transfer device (not shown) such as, for example, that described in PCT patent publication WO 2011/063499 to Halter et al. published on June 3, 2011. Alternatively, the molded part 280 may be allowed to simply fall from the mold 220 as shown.

The molding system 200 further includes a holder 260 that is selectively configurable to hold the core group 244 in each of the sequence of discrete molding configurations. In this non-limiting embodiment the holder 260 is integrated into the first mold part 222. However, the location of the holder is not so limited and may be located in other locations in the molding system, such as, for example, integrated within one of the platens (FIG. 5A), for performing substantially the same function. As shown with reference to FIGS. 3A and 3B, the holder 260 includes a mold support 262 and an actuator 261, governed by the controller 266, for selectively positioning a selected one of a plurality of support surfaces 262A, 262B of different heights that are defined on the mold support 262 in between a back plate of the ejector box 242 and an engagement member 264 that is attached to a rear of the core group 244. With further reference to FIG. 3C it may be appreciated that the mold support 262 is also positionable into a release configuration such that it is removed from beneath the engagement member 264 whereby the core group 244 is retractable to an ejection position.

Another non-limiting embodiment of the molding process 800 (FIG. 10) will now be described with reference to the operational sequence of FIGS. 3A-3C. The molding process includes maintaining 810 (FIG. 10) opposing platens of the mold clamp 210 at a shut height H that is kept substantially constant while performing the further operations listed hereafter. The further operations include holding 820 (FIG. 10) the relatively moveable parts of the mold 220 in each of the sequence of discrete molding configurations while molding 830 (FIG. 10) the molded article 280 (FIG. 3C) in a sequence of molding operations. The foregoing may be appreciated in greater detail beginning with reference to FIG. 3A wherein the core group 244 of the first

mold part 222 is being held in a first molding configuration of the sequence of discrete molding configurations relative to the second mold part 224 (stationary) to define a first molding cavity 258A therebetween. As can be seen the mold support 262 is positioned such that the taller support surface 162A is arranged beneath the engagement member 264 of the core group 244.

5 While not shown, a first of the sequence of molding operations is then performed with injection of a first molding material from the first injection unit 212 into the first molding cavity 258A to mold a first part 280A of the molded article 280 (FIG. 3C). Next with reference to FIG. 3B it may be appreciated that the core group 244 of the first mold part 222 is next held in a second molding configuration of the sequence of discrete molding configurations relative to the second
10 mold part 224 to define a second molding cavity 258B therebetween. In so doing, the mold support 262 has been repositioned such that the shorter support surface 262B is arranged beneath the engagement member 264 of the core group 244. Next, a second of the sequence of molding operations is performed, not shown, wherein a second molding material from the second injection unit 213 (which may or may not be different than the first molding material) is
15 injected into the second molding cavity 258B that includes the first part 280A of the molded article 280 to mold a second part 280B of the molded article 280 (FIG. 3C). The molding process 800 ends or repeats after a final operation of ejecting 840 (FIG. 10) the molded article 280 from the mold 220. As can be seen with reference to FIG. 3C, the foregoing may include selectively configuring the holder 260 into a release configuration wherein the mold support
20 262 is withdrawn to a position beside the engagement member 264 such that the core group 244 is effectively released for movement to an ejection configuration. In the ejection configuration the relatively moveable parts of the mold (i.e. first stack part 252 and the second stack part 254) are spaced apart, as shown, such that the mold article 280 may then be removed or ejected from therebetween.

25 With reference to FIG. 4A there is depicted a further non-limiting schematic embodiment of a mold 320. The mold 320 broadly includes a first mold part 322 and a second mold part 324 that together define a molding cavity between relatively movable parts thereof. Specifically, the molding cavity is defined between a first stack part 352 and a second stack part 354 of a mold
30 stack 350 that are associated with the first mold part 322 and the second mold part 324, respectively. The mold 320 is configured for use in a mold clamp of a molding machine, not shown, such as, for example, the mold clamp 110 of FIG. 1 that was described previously.

The mold 320 further includes a number of holders for holding relatively moveable parts of the
35 mold 320 in a sequence of discrete molding configurations. More particularly, the mold 320

includes the holder 160 (schematically represented by a pair of dashed lines that represent the different holding configurations thereof) for selectively holding a core member 355 of the first stack part 352 in a sequence of molding configurations (A, B) relative to a cavity that is defined in the second stack part 354. The mold 320 also includes a holder 360 (also schematically represented by a pair of dashed lines that represent the different holding configurations thereof) for selectively holding an outer core 356 of the first stack part 352 in a complementary sequence of molding configurations (A', B') relative to the cavity that is defined in the second stack part 354. The mold 320 may further include yet another holder, not shown, for selectively holding a stripper ring 357 of the first stack part 352 in yet another complementary sequence of molding configurations, not shown, relative to the second stack part 354.

A further non-limiting embodiment of the molding process 800 (FIG. 10) will now be described with reference to the operational sequence of FIGS. 4A-4C. The molding process includes maintaining 810 (FIG. 10) opposing platens of the mold clamp, not shown, at a shut height that is kept substantially constant while performing the further operations listed hereafter. The further operations include holding 820 (FIG. 10) the relatively moveable parts of the mold 320 in each of the sequence of discrete molding configurations while molding 830 (FIG. 10) the molded article 380 (FIG. 4C) in a sequence of molding operations. The foregoing may be appreciated in greater detail beginning with reference to FIG. 4A wherein the holder 160 is configured to hold the core member 355 of the first stack part 352 in a first molding configuration (A) of the sequence of discrete molding configurations relative to the cavity of the second stack part 354 (stationary). Likewise, the holder 360 is configured to hold the outer core 356 of the first stack part 352 in a first complementary molding configuration (A') of the complementary sequence of discrete molding configurations relative to the cavity of the second stack part 354. With the core member 355 and the outer core 356 being so held in the cavity of the second stack part 354, a first molding cavity 358A is defined therebetween. While not shown, a first of the sequence of molding operations is then performed with injection of a first molding material into the first molding cavity 358A to mold a first part 380A (FIG. 4B) of the molded article 380. Next, as shown with reference to FIG. 4B, it may be appreciated that the holder 160 is reconfigured to hold the core member 355 in a second molding configuration (B) of the sequence of discrete molding configurations relative to the cavity. In addition, the holder 360 is configured to hold the outer core 356 in a second complementary molding configuration (B') of the complementary sequence of discrete molding configurations relative to the cavity. With the core member 355 and the outer core 356 being so held in the cavity of the second stack part 354, a second molding cavity 358B is defined therebetween that includes the first

part 380A. Next, as shown with reference to FIG. 4C, a second of the sequence of molding operations is performed, not shown, wherein a second molding material (which may or may not be different than the first molding material) is injected into the second molding cavity 358B to mold a second part 380B of the molded article 380. The molding process 800 ends or repeats
5 after a final operation of ejecting 840 (FIG. 10) the molded article 380 from the mold 320. The foregoing may include selectively configuring the holders 160, 360 into a release configuration, not shown, whereafter the relatively moveable parts of the mold are retracted such that the mold article 380 may then be removed or ejected therefrom.

10 Reference shall now be made to FIGS. 5A-5C that depict a schematic operating sequence of a molding system 300 performing a non-limiting embodiment of the molding process 800 (FIG. 10). The molding system 300 is structured much like the molding system 200 of FIG. 3A that was described previously. As such, common components between these systems have been
15 given the same reference numerals and will not be further described in detail hereafter. That being said, it may be noted that the molding system 300 broadly includes a mold clamp 310, for clamping a mold 410 between opposing platens 314, 216 thereof, and a pair of injection units 212, 213 for preparing and injecting molding materials into a mold 420 via a melt distributor 230 that is associated with the mold 420.

20 Like the mold 320 (FIG. 3A) described previously, the mold 420 includes a first mold part 422 and a second mold part 424 that are associated with opposite platens 314, 216 of the mold clamp 310. Relatively moveable parts of a mold stack 450 are associated with the parts of the mold 420 with which to successively define a molding cavity therebetween and to release a
25 molded article therefrom. Specifically, the mold stack 450 includes a first stack part 452 and a second stack part 454 that are associated with the first mold part 422 and the second mold part 424, respectively. In this non-limiting embodiment, the first stack part 452 includes a core member 455, an outer core 456 and a stripper ring 457. The second stack part 454 defines a cavity. The first mold part 422 also includes a mold cassette 440 that is contained, in part,
30 within an ejector box 342. In contrast with the earlier embodiment, the ejector box 342 is now associated with the platen 314 of the mold clamp 310. That is, the ejector box may be considered to be part of the mold clamp 310 for use with other mold cassettes, not shown, if retooling the molding machine. The mold cassette 440 includes a core group 444, an outer core group 446 and a stripper ring group 448. As their names imply, each of the core group 444, the
35 outer core group 446 and the stripper ring group 448 include a retainer plate onto which the core member 455, the outer core 456 and the stripper ring 457 is attached, respectively.

Additional members of further mold stacks, not shown, could be similarly attached thereto and in this way be moved in tandem. The core group 444 is selectively positionable relative to the second mold part 424 by means of the actuator 218, governed by the controller 266. In so doing, the core member 455 that is associated with the core group 444 may be selectively
5 positioned between a sequence of discrete molding configurations within the cavity of the second stack part 454. Likewise, the outer core group 446 and the stripper ring group 448 are also selectively positionable relative to the second mold part 424 by means of further actuators, not shown, governed by the controller 266, or other mechanical means (e.g. spring, stroke limiter, etc.). In so doing, the outer core 456 and the stripper ring 457 that are associated
10 therewith may be selectively positioned between complementary sequences of discrete molding configurations with respect to the cavity of the second stack part 454.

The molding system 300 further includes a holder 460 that is selectively configurable to hold the core group 444 in each of the sequence of discrete molding configurations. In this non-
15 limiting embodiment the holder 460 is integrated into the platen 314 of the mold clamp 310. As shown with reference to FIGS. 5A, the holder 460 includes a mold support 462 and an actuator 461, governed by the controller 266, for selectively positioning a selected one of a plurality of support surfaces 462A, 462B of different heights that are defined on the mold support 462 behind an engagement member 464 that is attached to a rear of the core group 444. With further
20 reference to FIG. 5C it may be appreciated that the mold support 462 is also positionable into a release configuration such that it is removed from beneath the engagement member 264 whereby the core group 444 is retractable to an ejection position.

The mold 420 includes a further holder 560, governed by the controller 266, that is arranged
25 between the core group 444 and the outer core group 446. The further holder 560 is selectively configurable to control a spacing therebetween and in so doing hold the outer core group 446 on which the outer core 456 is associated in a complementary sequence of discrete molding configurations. Similarly, the mold 420 further includes another holder 660, governed by the controller 266, that is arranged between the outer core group 446 and the stripper ring group
30 448. The holder 660 is selectively configurable to control a spacing therebetween and in so doing hold the stripper ring group 448 on which the stripper ring 457 is associated in another complementary sequence of discrete molding configurations.

A further non-limiting embodiment of the molding process 800 (FIG. 10) will now be
35 described with reference to the operational sequence of FIGS. 5A-5C. The molding process

includes maintaining 810 (FIG. 10) opposing platens of the mold clamp 310 at a shut height H that is kept substantially constant while performing the further operations listed hereafter. The further operations include holding 820 (FIG. 10) the relatively moveable parts of the mold 420 in each of the sequence of discrete molding configurations while molding 830 (FIG. 10) the molded article 480 (FIG. 5C) in a sequence of molding operations. The foregoing may be appreciated in greater detail beginning with reference to FIG. 5A wherein the holder 460 is configured to hold the core group 444 of the mold cassette 440 in a first molding configuration of the sequence of discrete molding configurations relative to the cavity of the second mold part 424 (stationary). Likewise, the further holders 560, 660 are configured to hold the outer core group 446 and the stripper ring group 448 in their first complementary molding configurations relative to the cavity of the second stack part 454. With the groups of the mold cassette 440 being so held, the members of the first stack part 452 cooperate with the cavity of the second stack part 454 to define a first molding cavity 458A therebetween. While not shown, a first of the sequence of molding operations is then performed with injection of a first molding material into the first molding cavity 458A to mold a first part 480A (FIG. 5C) of the molded article 480. Next, as shown with reference to FIG. 5B, it may be appreciated that the holder 460 is reconfigured to hold the core group 444 in a second molding configuration of the sequence of discrete molding configurations relative to the cavity. In addition, the further holders 560, 660 are reconfigured to hold the outer core group 446 in a second complementary molding configuration relative to the cavity of the second stack part 454. With the groups of the mold cassette 440 being so held, the members of the first stack part 452 cooperate with the cavity of the second stack part 454 to define a first molding cavity 458B therebetween that includes the first part 480A (FIG. 5C) of the molded article 480 therein. Next, a second of the sequence of molding operations is performed, not shown, wherein a second molding material (which may or may not be different than the first molding material) is injected into the second molding cavity 458B to mold a second part 380B (FIG. 5C) of the molded article 480. The molding process 800 ends or repeats after a final operation of ejecting 840 (FIG. 10) the molded article 480 (FIG. 5C) from the mold 420. The foregoing may be appreciated with reference to FIG. 5C, wherein the holder 460 has been reconfigured into a release configuration allowing the entire mold cassette 440 to be retracted a first distance whereafter motion of the stripper ring group 448 stops and the core group 444 and the outer core group 446 continue to retract to an ejection configuration. In so doing, the molded article 480 is bumped, or stripped, from the first stack part 452.

With reference to FIG. 6 there is depicted yet another non-limiting schematic embodiment of a holder 760 that is configured for holding relatively moveable parts of a mold that is positioned between the opposing platens of a mold clamp in a sequence of discrete molding configurations. Similar to the non-limiting embodiments of holders described previously, the holder 760 includes a mold support 762 and an actuator 761 for selectively positioning a selected one of a plurality of support surfaces 762A, 762B, 762C of different heights that are defined thereon between a platen of the mold clamp (not shown) and the first stack part 352 (FIG. 7A) to support a core member 355 of the first stack part 152 in each of the discrete molding configurations (A, B, C – FIGS. 7A-7E).

A further non-limiting embodiment of the molding process 800 (FIG. 10) will now be described with reference to the sequence of FIGS. 7A-7E. The molding process includes maintaining 810 (FIG. 10) opposing platens of the mold clamp, not shown, at a shut height that is kept substantially constant while performing the further operations listed hereafter. The further operations include holding 820 (FIG. 10) the relatively moveable parts of the mold 320 in each of the sequence of discrete molding configurations while molding 830 (FIG. 10) the molded article 580 in a sequence of molding operations. The foregoing may be appreciated in greater detail beginning with reference to FIG. 7A wherein the holder 760 is configured to hold the relatively moveable parts of the mold 320 in a first molding configuration (A) of the sequence of discrete molding configurations to define a first molding cavity 558A therebetween. Next, a first of the sequence of molding operations is performed, not shown, wherein a first molding material is injected into the first molding cavity 558A to mold a first part 580A (FIG. 7B) of the molded article 580. Next, as shown with reference to FIG. 7B, the holder 760 is reconfigured to hold the relatively moveable parts of the mold 320 in a second molding configuration (B) of the sequence of discrete molding configurations to define a second molding cavity 558B therebetween. Next, with reference to FIG. 7C a second of the sequence of molding operations may be appreciated wherein a second molding material (which may or may not be different than the first molding material) is injected into the second molding cavity 558B that includes the first part 580A of the molded article 580 to mold a second part 580B of the molded article 580. Next, as shown with reference to FIG. 7D, the holder 760 is yet again reconfigured to hold the relatively moveable parts of the mold 320 in a third molding configuration (C) of the sequence of discrete molding configurations to define a third molding cavity 558C therebetween. Next, with reference to FIG. 7D a third of the sequence of molding operations may be appreciated wherein a third molding material (which may or may not be different than the first and/or second molding materials) is injected into the third molding

cavity 558C that includes the second part 580B of the molded article 580 to mold a third part 580C of the molded article 580. The molding process 800 ends or repeats after a final operation of ejecting 840 (FIG. 10) the molded article 580 from the mold 320. The foregoing may include selectively configuring the holder 760 into a release configuration, not shown. In the ejection
5 configuration the relatively moveable parts of the mold (i.e. first stack part 352 and the second stack part 354) are spaced apart, not shown, such that the mold article 580 may be removed from therebetween.

The foregoing non-limiting embodiments of the molding apparatus and related molding
10 process, and variants thereof, may be useful in molding a variety of different molded articles. For example, and without specific limitation, the molded article may be a preform 680 or closure 780 as shown with reference to FIGS. 8 and 9. The preform 680 shown is of the variety that is subsequently blow molded into a container, such as a bottle (not shown). The preform 680 includes a neck finish 681 at an open end thereof and a body 682 at the closed end thereof.
15 The neck finish 681 is configured for receiving the closure 780 for capping the container that is blown from the body 682. The foregoing molding process 800 may be adapted, for example, to mold the preform 680 and closure 780 from multiple molding materials. For instance, the body 682 of the preform could be molded to include multiple layers of molding material of different composition. Similarly, the closure 780 may be molded such that the shell of the closure and
20 the seal of the closure may be formed of different molding compositions. In a further non-limiting example, the molding process 800 could be adapted such that the holding 820 and molding 830 operations are performed to reduce a volume of the molding cavity between molding operations and thereby compress molding material therein. Specifically, the holder may be configured to hold the moveable parts of the mold in a first molding configuration
25 (expanded) of the sequence of discrete molding configurations whereafter in a first molding operation molding material is injected therein. Thereafter, the holder may be reconfigured to hold the relatively movable parts of the mold in a second molding configuration, wherein a volume of the molding cavity is reduced, whereby the second molding operation is a coining or compression of the molding material (replace hold operation of a typical molding process).

30 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
35 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 them 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 molding process (800), comprising:
 - maintaining (810) opposing platens of a mold clamp (110, 210, 310) at a shut height (H) that is kept substantially constant while performing the further operations of:
 - holding (820) relatively moveable parts of a mold (120, 220, 320, 420) that is positioned between the opposing platens of the mold clamp (110, 210, 310) in a sequence of discrete molding configurations;
 - molding (830) a molded article (180, 280, 380, 480) with a sequence of molding operations in the discrete molding configurations; and
 - ejecting (840) the molded article (180, 280, 380, 480, 580) from the mold (120, 220, 320, 420).
2. The molding process of claim 1, wherein:
 - the holding (820) of the relatively moveable parts of the mold (120, 220, 320, 420) in the sequence of discrete molding configurations includes:
 - holding the relatively moveable parts of the mold (120, 220, 320, 420) in a first molding configuration (A) to define a first molding cavity (158A, 258A, 358A, 458A, 558A) therebetween; and then
 - holding the relatively moveable parts of a mold (120, 220, 320, 420) in a second molding configuration (B) to define a second molding cavity (158B, 258B, 358B, 458B, 558B) therebetween.
3. The molding process of claim 2, wherein:
 - the sequence of molding operations includes:
 - injecting a first molding material into the first molding cavity (158A, 258A, 358A, 458A, 558A) to mold a first part (180A, 280A, 380A, 480A) of the molded article (180, 280, 380, 480, 580); and
 - injecting a second molding material into the second molding cavity (158B, 258B, 358B, 458B, 558B) to mold a second part (180B, 280B, 380B, 480B) of the molded article (180, 280, 380, 480, 580).
4. The molding process of claim 3, wherein:
 - the holding (820) of the relatively moveable parts of the mold (320) in the sequence of discrete molding configurations and the molding (830) operations further includes:

holding the relatively moveable parts of the mold (320) in a third molding configuration (C) to define a third molding cavity (558C) therebetween; and
injecting a further molding material into the third molding cavity (558C) to mold a third part (580C) of the molded article (580).

5. The molding process of any preceding claim, wherein:
the holding (820) the relatively moveable parts of the mold (120, 220, 320, 420) in each of the discrete molding configurations includes selectively configuring a holder (160, 260, 360, 460, 760) into a corresponding one of a plurality of holding configurations.
6. The molding process of claim 5, wherein:
the ejecting (840) the molded article (180, 280, 380, 480, 580) from the mold (120, 220, 320, 420) includes selectively configuring the holder (160, 260, 360, 460, 760) into a release configuration, whereby the relatively moveable parts of the mold (120, 220, 320, 420) are released for movement to an ejection configuration.
7. The molding process of claim 5 or 6, further comprising:
reducing, at least in part, a clamp force being applied to the mold (120, 220, 320, 420) by the mold clamp (110, 210, 310) prior to selectively configuring the holder (160, 260, 360, 460, 760) and movement of the relatively moveable parts of the mold (120, 220, 320, 420).
8. The molding process of any of claims 5, 6, or 7, wherein:
the holding (820) relatively moveable parts of the mold (120, 220, 320, 420) includes holding one or more members of a first stack part (152, 252, 352, 452) in the sequence of discrete molding configurations relative to a second stack part (154, 254, 354, 454) of a mold stack (150, 250, 350, 450) that are associated with a first mold part (122, 222, 322, 422) and a second mold part (124, 224, 324, 424), respectively.
9. The molding process of claim 8, wherein:
the holding (820) relatively moveable parts of the mold (220, 420) in each of the discrete molding configurations includes selectively configuring the holder (260, 460) into each of the plurality of holding configurations to hold a mold group of a mold cassette (240, 440) on which a member of the first stack part (252, 452) is associated in the sequence of discrete molding configurations relative to the second stack part (254, 454) that is associated with the second mold part (224, 424).

10. The molding process of claim 9, wherein:
 - the holding (820) relatively moveable parts of the mold (220, 420) in each of the discrete molding configurations includes selectively configuring the holder (260, 460) into each of the plurality of holding configurations to hold a core group (244, 444) of the mold cassette (240, 440) on which a core member (255, 455) of the first stack part (252, 452) is associated in the sequence of discrete molding configurations.
11. The molding process of claim 10, further comprising:
 - selectively configuring a further holder (560) into a further plurality of holding configurations to hold an outer core group (446) of the mold cassette (440) on which an outer core (456) of the first stack part (452) is associated in a complementary sequence of discrete molding configurations.
12. The molding process of claim 11, wherein:
 - selectively configuring another holder (660) into another plurality of holding configurations to hold a stripper ring group (448) of the mold cassette (440) on which a stripper ring (457) of the first stack part (452) is associated in another sequence of discrete molding configurations.
13. The molding process of any one of claims 9, 10, 11, or 12, wherein:
 - the ejecting (840) the molded article (280, 480) from the mold (220, 420) includes selectively configuring the holder (160, 260, 360, 460, 560, 660, 760) into a release configuration.
14. The molding process of claim 13, further comprising:
 - holding the stripper ring group (448) in a stripping position; and
 - retracting one or more remaining mold group of the mold cassette (240, 440) to an ejection position.
15. The molding process of claim 1, wherein:
 - the holding (820) and molding (830) operations are performed to reduce a volume of the molding cavity between molding operations and thereby compress molding material therein.
16. A computer program product storing computer readable instructions for execution by a controller (266) of a molding system (200, 300) for performing the molding process (800) of any one of claims 1 through 14.

17. A molding apparatus, comprising:
 - a holder (160, 260, 360, 460, 760) that is selectively configurable into a plurality of holding configurations to hold relatively moveable parts of a mold (120, 220, 320, 420) in a sequence of discrete molding configurations with the mold (120, 220, 320, 420) positioned between opposing platens of a mold clamp (110, 210, 310) that are maintained at a shut height (H) that is kept substantially constant, whereby a sequence of molding operations may be performed in the discrete molding configurations to mold a molded article (180, 280, 380, 480).
18. The molding apparatus of claim 17, wherein:
 - the plurality of holding configurations include:
 - a first holding configuration, wherein the holder (160, 260, 360, 460, 760) is configured for holding the relatively moveable parts of the mold (120, 220, 320, 420) in a first molding configuration (A) to define a first molding cavity (158A, 258A, 358A, 458A, 558A) therebetween within which to mold a first part (380A) of the molded article (380); and
 - a second holding configuration, wherein the holder (160, 260, 360, 460, 760) is configured for holding the relatively moveable parts of a mold (120, 220, 320, 420) in a second molding configuration (B) to define a second molding cavity (158B, 258B, 358B, 458B, 558B) therebetween within which to mold a second part (380B) of the molded article (380).
19. The molding apparatus of claim 18, wherein:
 - the holder (760) is furthermore selectively configurable into a third holding configuration for holding the relatively moveable parts of the mold (320) in a third molding configuration (C) to define a further molding cavity (558C) therebetween within which to mold a third part (580C) of the molded article (580).
20. The molding apparatus of any preceding claim, wherein:
 - the holder (160, 260, 360, 460, 760) is furthermore selectively configurable into a release configuration, whereby the relatively moveable parts of the mold (120, 220, 320, 420) are released for movement to an ejection configuration to eject the molded article (180, 280, 380, 480) from the mold (120, 220, 320, 420).
21. The molding apparatus of any preceding, wherein:

the relatively moveable parts of the mold (120, 220, 320, 420) include a first stack part (152, 252, 352, 452) and a second stack part (154, 254, 354, 454) of a mold stack (150, 250, 350, 450) that are associated with a first mold part (122, 222, 322, 422) and a second mold part (124, 224, 324, 424), respectively.

22. The molding apparatus of claim 21, wherein:

the holder (160, 260, 360, 460, 760) includes a mold support (162, 262, 462, 762) that is selectively positionable into a plurality of holding positions to position a selected one of a plurality of support surfaces (162A, 162B, 262A, 262B, 462A, 462B, 762A, 762B, 762C) of different height that are defined thereon to support the first stack part (152, 252, 352, 452) in each of the discrete molding configurations.

23. The molding apparatus of claim 22, wherein:

the mold support (162, 262, 462, 762) is furthermore selectively positionable to a release position that allows the first stack part (152, 252, 352, 452) to be moved to the ejection configuration.

24. The molding apparatus of any preceding claim, wherein:

the first mold part (222, 422) includes a mold cassette (240, 440) that includes a mold group on which a member of the first stack part (252, 452) is associated, and wherein the holder (260, 460) is configured to hold the mold group including the member of the first stack part (252, 452) in each of the discrete molding configurations.

25. The molding apparatus of claim 24, wherein:

the holder (260) is associated with the first mold part (222, 422).

26. The molding apparatus of claim 25, wherein:

the holder (260) is associated with an ejector box (242) of the first mold part (222, 422) that contains the mold cassette (240).

27. The molding apparatus of claim 24, wherein:

the holder (460) is associated with a first platen (314) of the mold clamp (310).

28. The molding apparatus of claim 27, wherein:

the holder (460) is associated with an ejector box (342) that is connected to the first platen (314) that contains the mold cassette (440).

29. The molding apparatus of claim 24, wherein:
the mold group of the mold cassette (240, 440) is a core group (244, 444) that includes a core member (255, 455) of the first stack part (252, 452).
30. The molding apparatus of claim 29, wherein:
the core group (244, 444) includes an engagement member (264, 464) that is configured to cooperate with the mold support (262, 462) of the holder (260, 460).
31. The molding apparatus of claim 30, further comprising:
a further holder (560) that is selectively configurable to hold an outer core group (446) of the mold cassette (440) on which an outer core (456) of the first stack part (452) is associated in a complementary sequence of discrete molding configurations.
32. The molding apparatus of claim 31, wherein:
the further holder (560) is arranged between the core group (444) and the outer core group (446) of the mold cassette (440) for controlling a spacing therebetween.
33. The molding apparatus of one of claims 31 or 32, further comprising:
another holder (660) that is selectively configurable to hold a stripper ring group (448) of the mold cassette (440) on which a stripper ring (457) of the first stack part (452) is associated in another sequence of discrete molding configurations.
34. The molding apparatus of claim 33, wherein:
the another holder (660) is arranged between the outer core group (446) and the stripper ring group (448) of the mold cassette (440) for controlling a spacing therebetween.
35. The molding apparatus of any one of claims 29, 30, 31, 32, 33 or 34, wherein:
with selective configuration of one or more of the holder (260, 460), the further holder (560) and the another holder (660) into the release configuration selected groups of the mold cassette (240, 440) are released for movement to an ejection configuration to eject the molded article (180, 280, 380, 480) from the mold (120, 220, 320, 420).

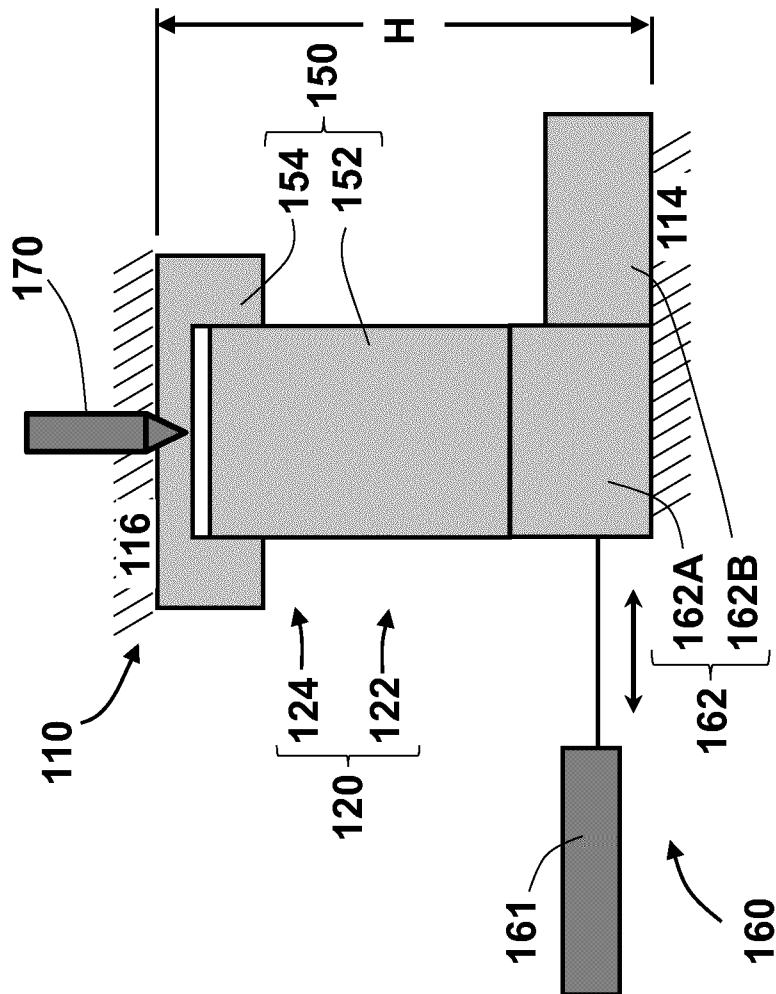
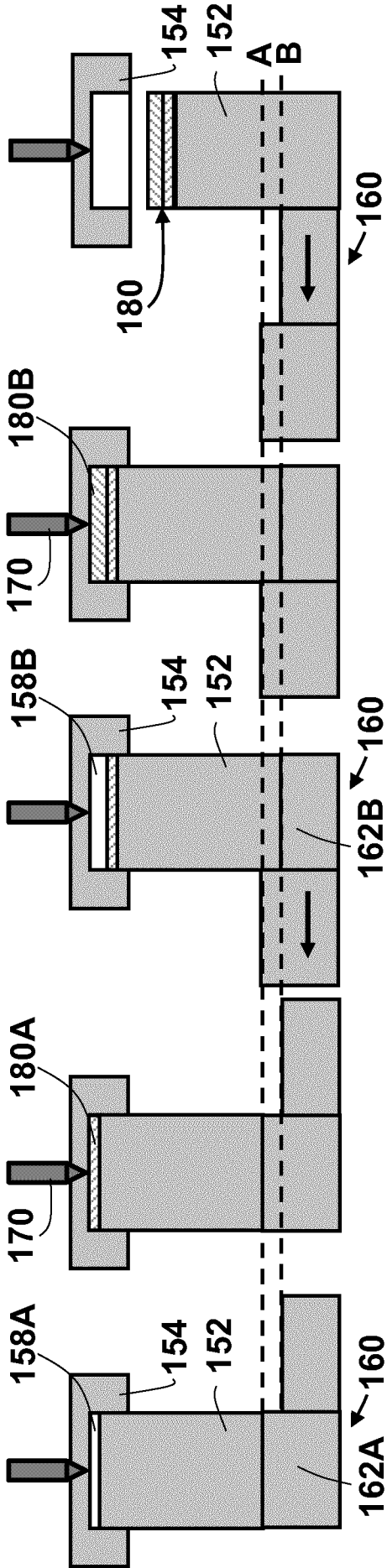


FIG. 1



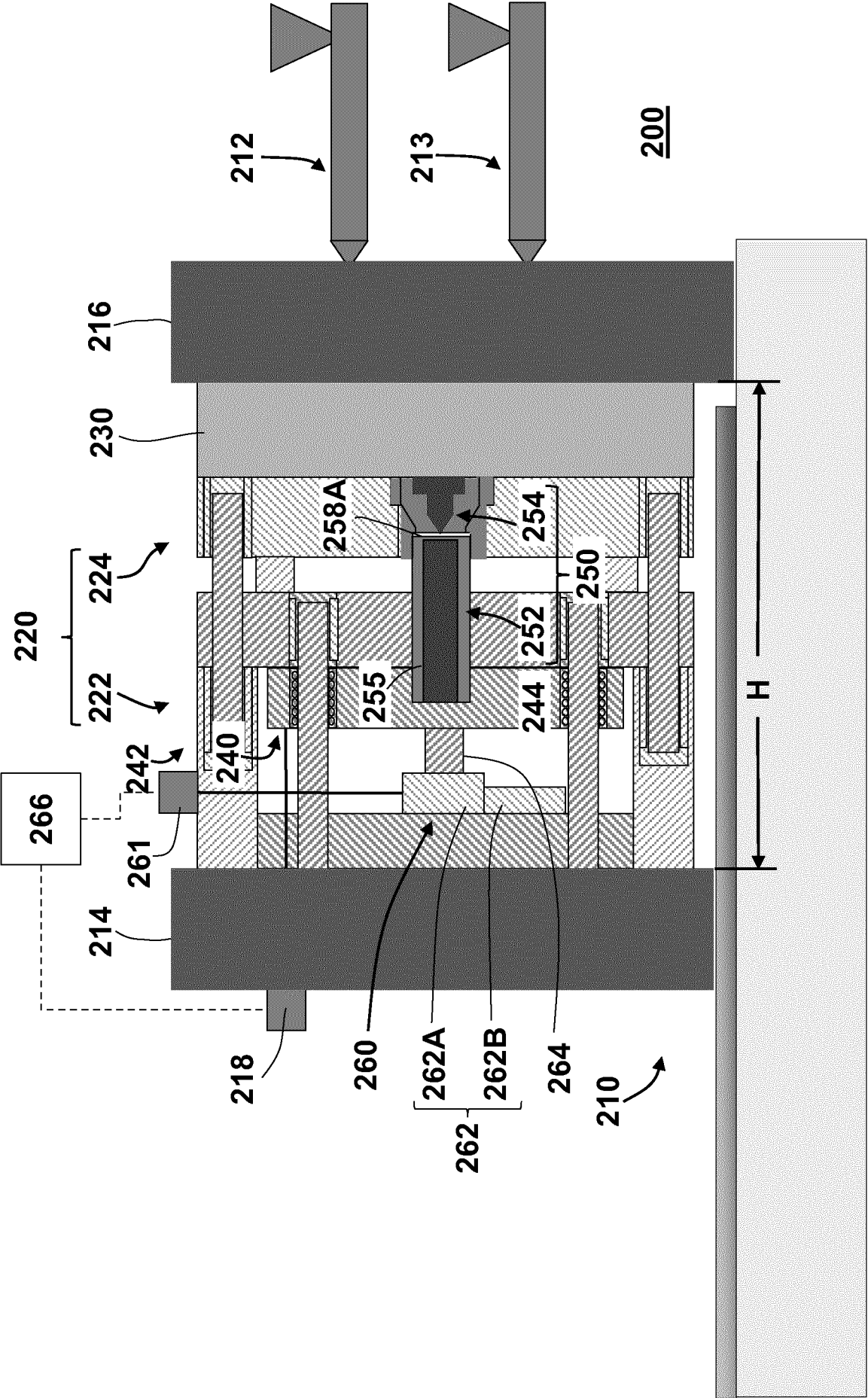


FIG. 3A

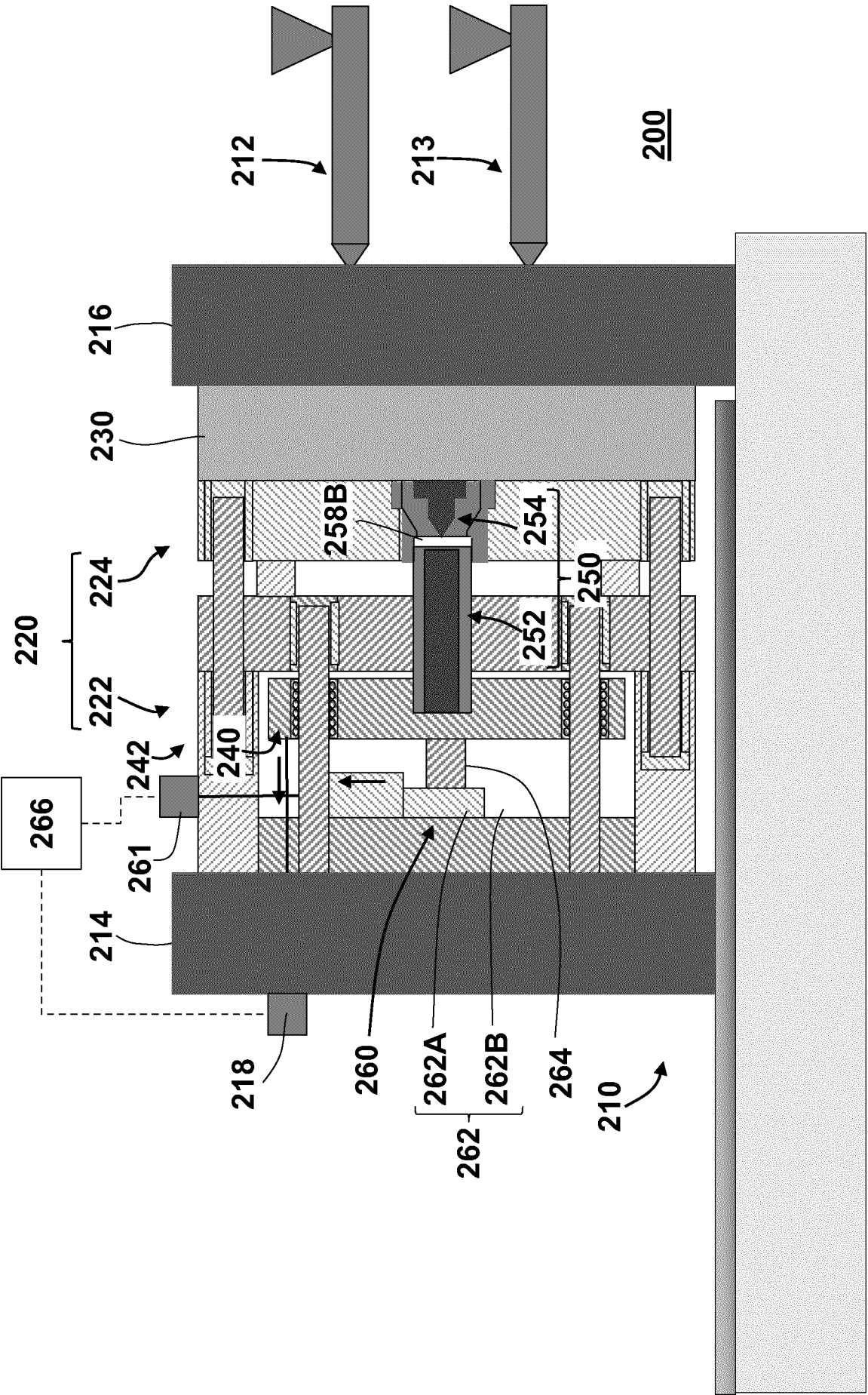


FIG. 3B

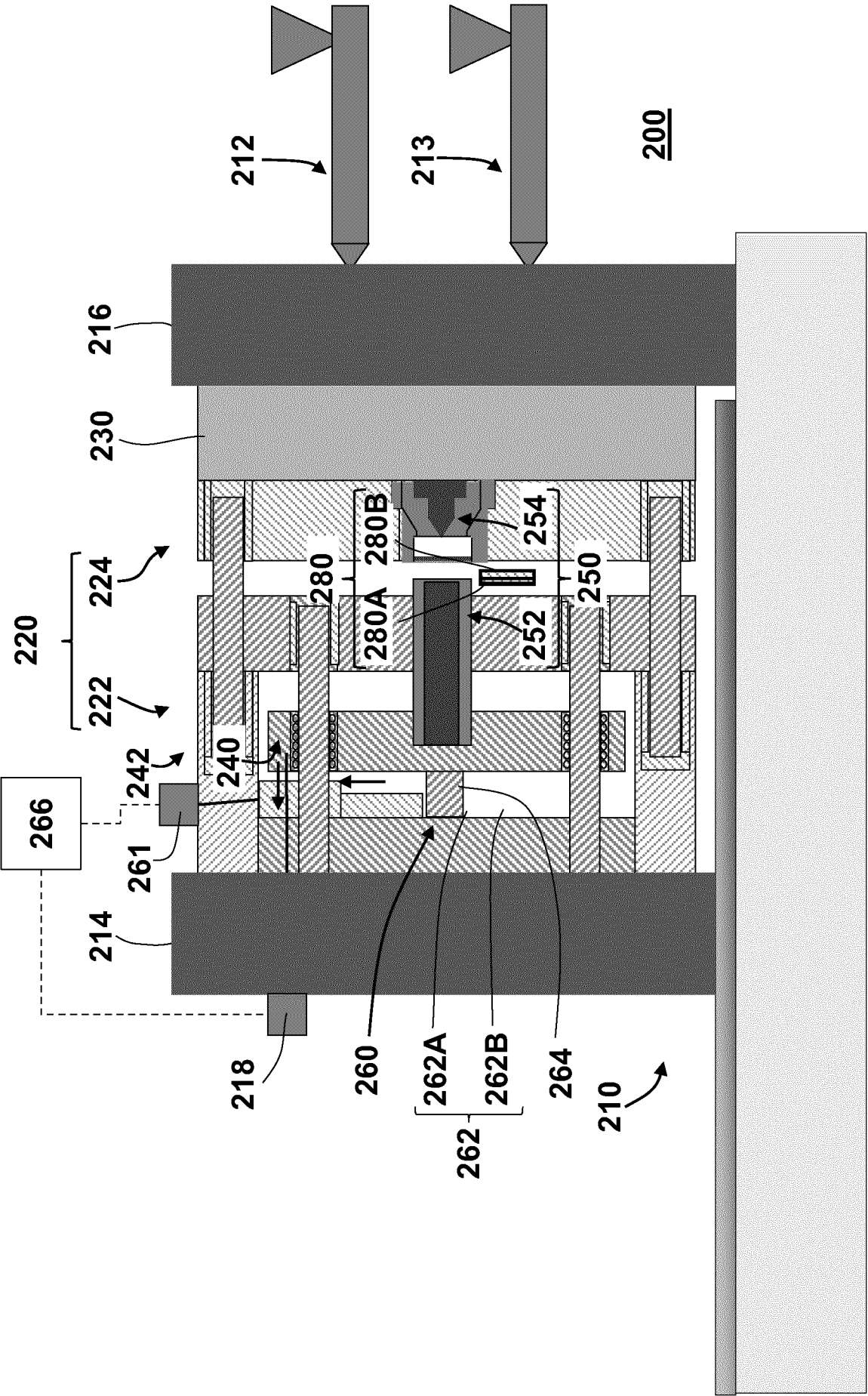
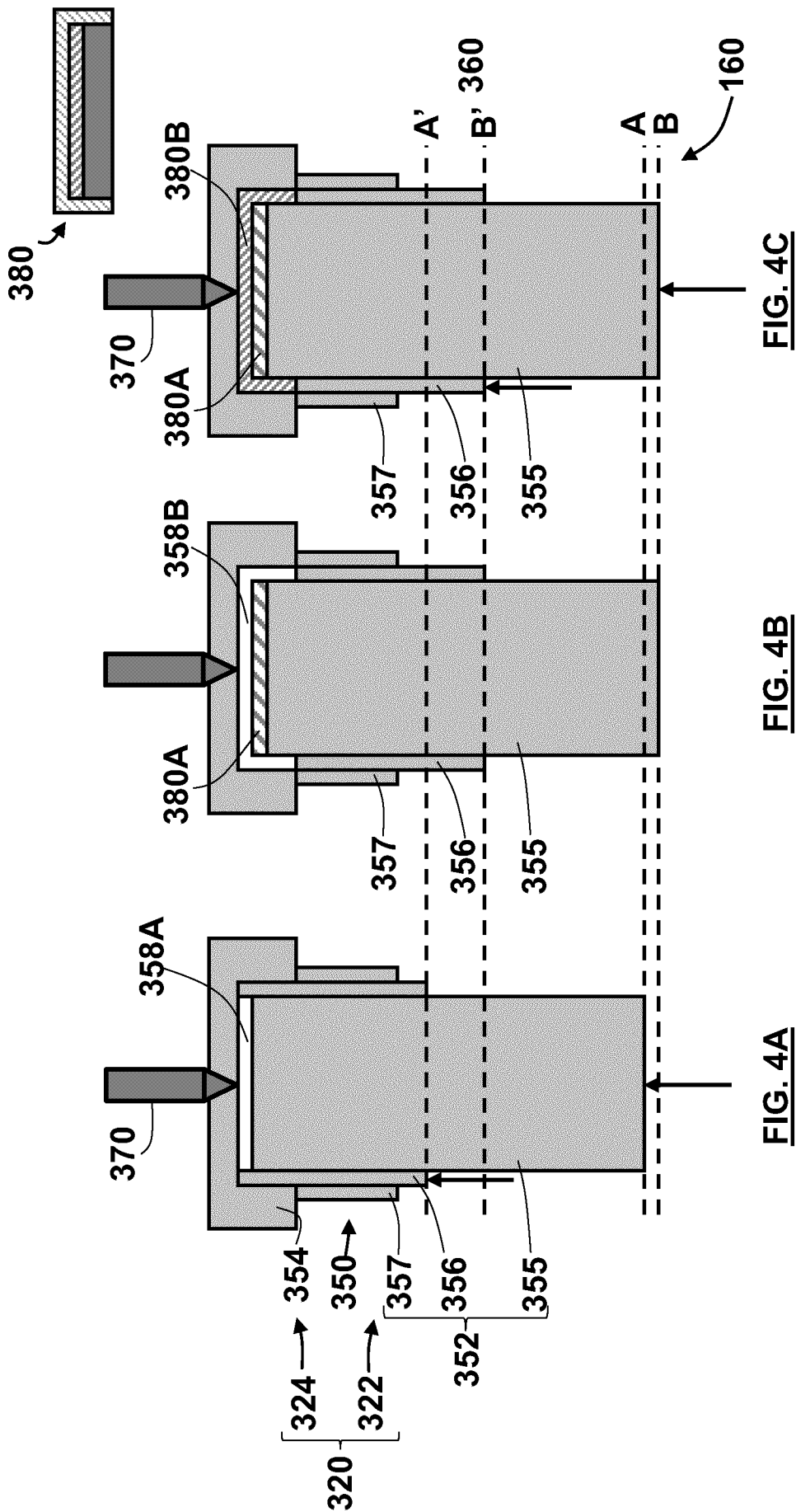


FIG. 3C



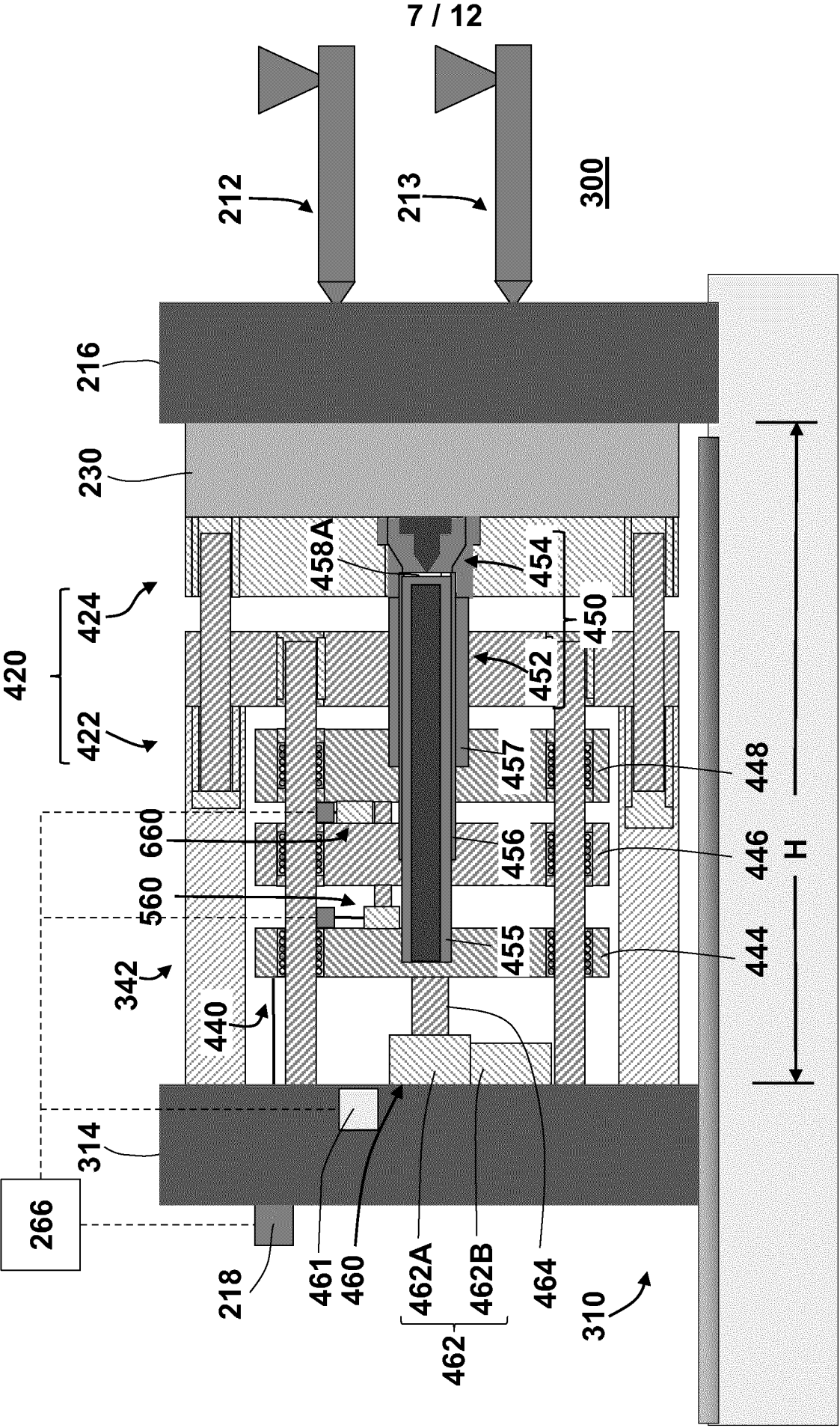


FIG. 5A

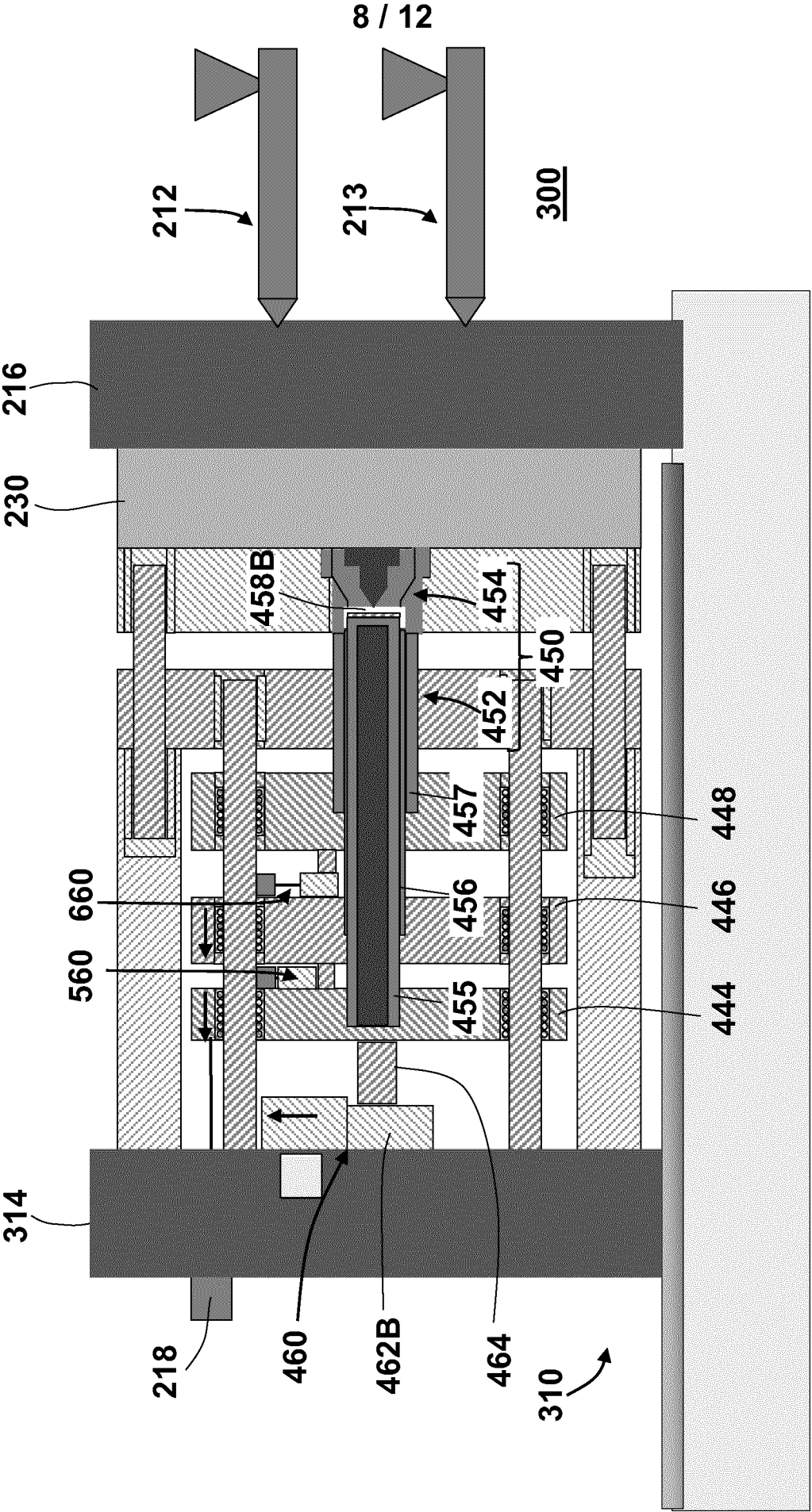


FIG. 5B

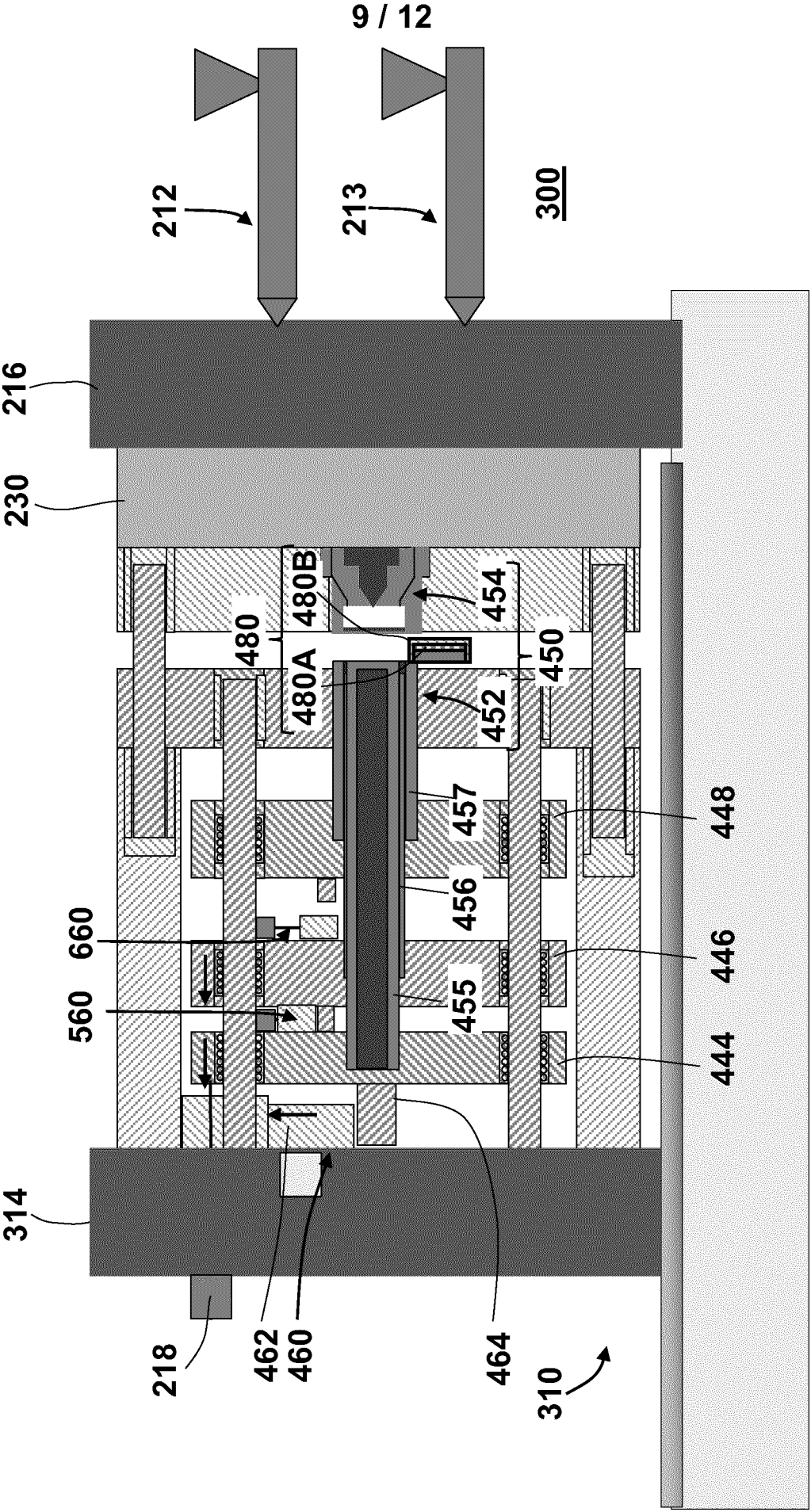


FIG. 5C

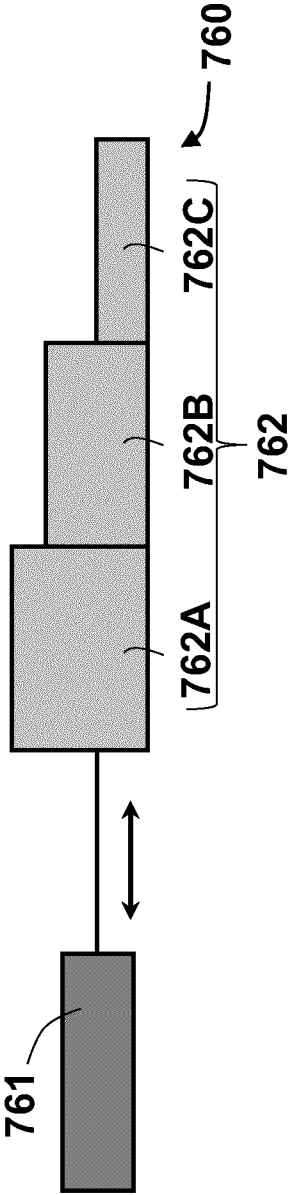
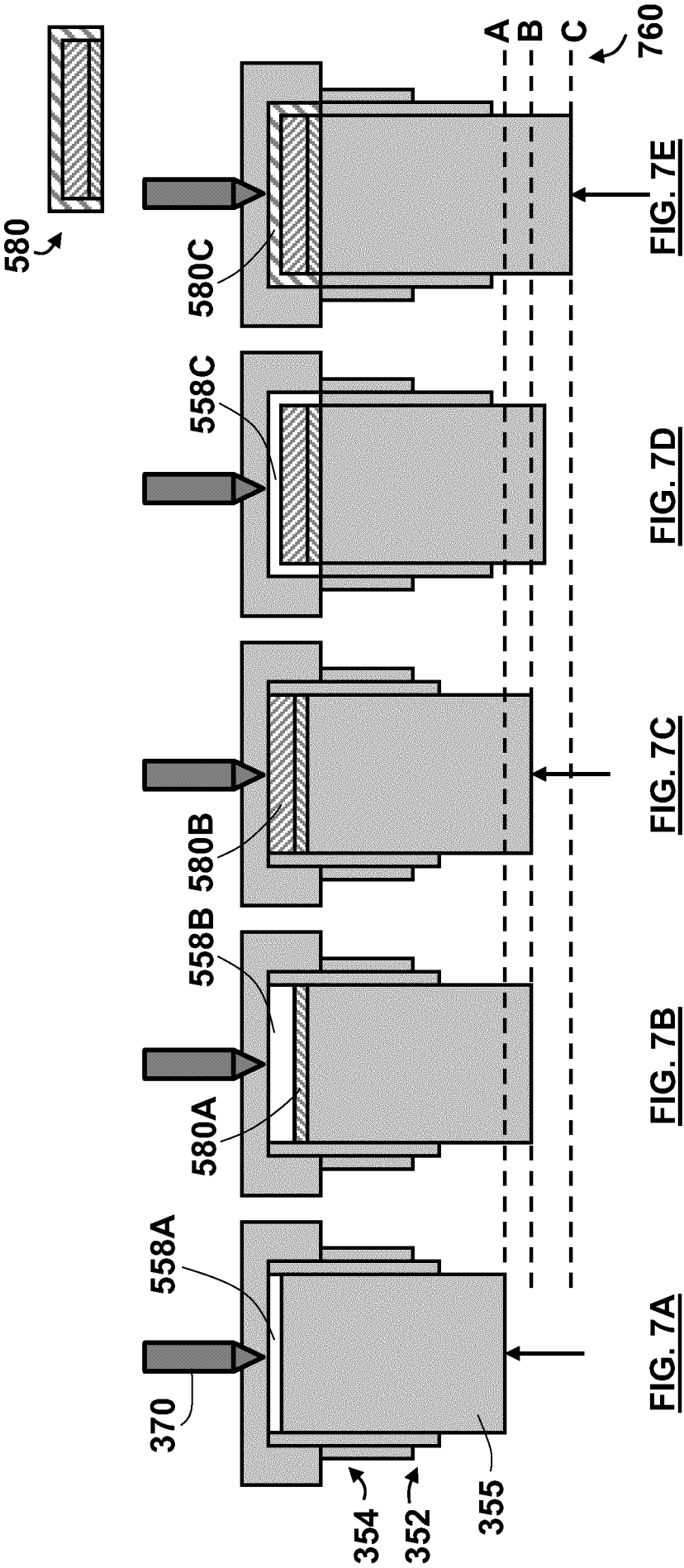


FIG. 6

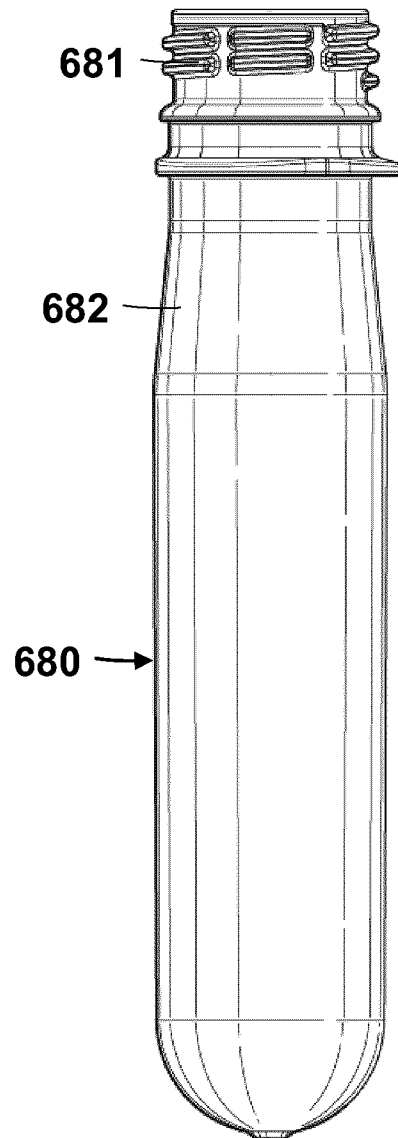


FIG. 8

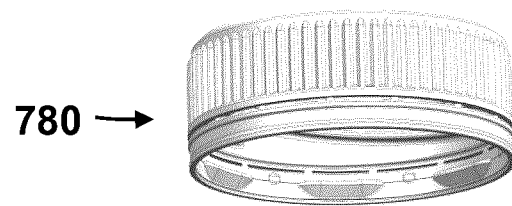
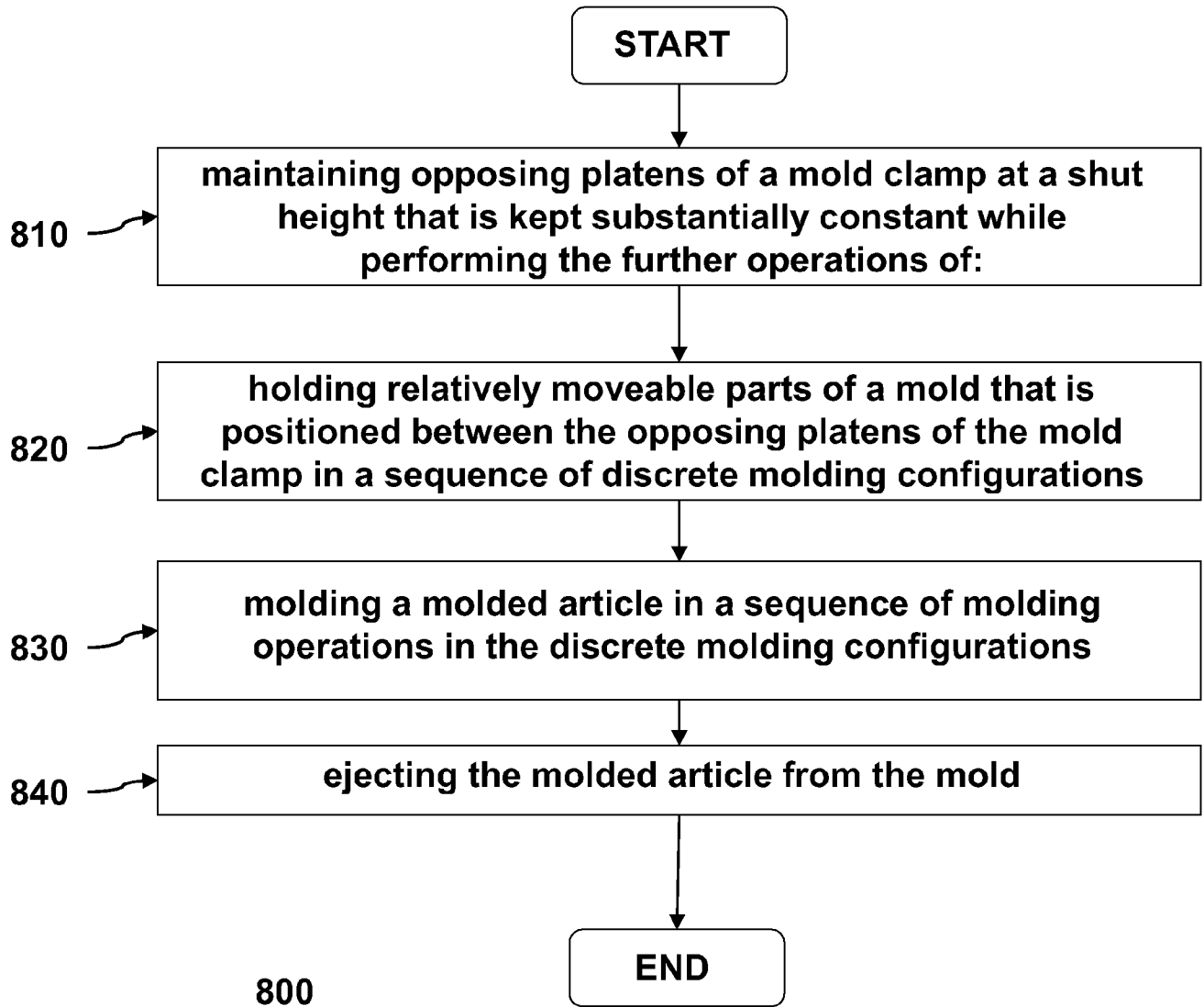


FIG. 9

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**FIG. 10**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA2014/050164

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **B29C 45/17** (2006.01), **B29C 45/40** (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, cavit*, core, sequential mold*, multi-layer*, mutiple layer*, first melt, first mold*, material, first material and mov* core.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5651998 A (BERTSCHI, R. A. et al.) 29 July 1997 (29-07-1997) *figs. 7-8; col. 6, lines 1-17*	1-35
A	WO 2012/160952 A1 (OKAMOTO, A. et al.) 29 November 2012 (29-11-2012) *whole document*	1-35

 Further documents are listed in the continuation of Box C.

 See patent family annex.

* "A" "E" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance earlier application or patent but published on or after the international filing date 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 referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" "X" "Y" "&"	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 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 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 document member of the same patent family
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Date of the actual completion of the international search
07 May 2014 (07-05-2014)

Date of mailing of the international search report
23 May 2014 (23-05-2014)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
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Facsimile No.: 001-819-953-2476

Authorized officer

Pengfei Zhang (819) 953-0654

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA2014/050164

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US 5651998 A	29 July 1997 (29-07-1997)	US5651998A AT193860T DE69517471D1 DE69517471T2 DK0688652T3 EP0688652A1 EP0688652B1 HK1011636A1 JPH0839609A JP2993866B2 US5798069A US5789033A	29 July 1997 (29-07-1997) 15 June 2000 (15-06-2000) 20 July 2000 (20-07-2000) 08 March 2001 (08-03-2001) 23 October 2000 (23-10-2000) 27 December 1995 (27-12-1995) 14 June 2000 (14-06-2000) 09 February 2001 (09-02-2001) 13 February 1996 (13-02-1996) 27 December 1999 (27-12-1999) 25 August 1998 (25-08-1998) 04 August 1998 (04-08-1998)
WO 2012/160952 A1	29 November 2012 (29-11-2012)	WO2012160952A1 JP2013006419A JP5152430B2 JP5152438B2 US2014077406A1	29 November 2012 (29-11-2012) 10 January 2013 (10-01-2013) 27 February 2013 (27-02-2013) 27 February 2013 (27-02-2013) 20 March 2014 (20-03-2014)