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61/781,318 14 March 2013 (14.03.2013) US(71) Applicant: **HUSKY INJECTION MOLDING SYSTEMS LTD.** [CA/CA]; 500 Queen Street South, Bolton, Ontario L7E 5S5 (CA).(72) Inventors: **JENKO, Edward Joseph**; 100 Lamore Road, Essex, Vermont 05452 (US). **ESSER, Brian**; 151 Broadlake Road, Colchester, Vermont 05446 (US). **BELZILE, Manon Danielle**; 353 Hill Road, Fairfield, Vermont 05455 (US). **DEZON-GAILLARD, Patrice Fabien**; 24 Kettle Creek Road, Jericho, Vermont 05465 (US). **MIER, Angelo**; 170 S. Bay Circle, Colchester, Vermont 05446 (US).(74) Agent: **MUSGRAVE, Richard, J.**; 288 North Road, Milton, Vermont 05468 (US).

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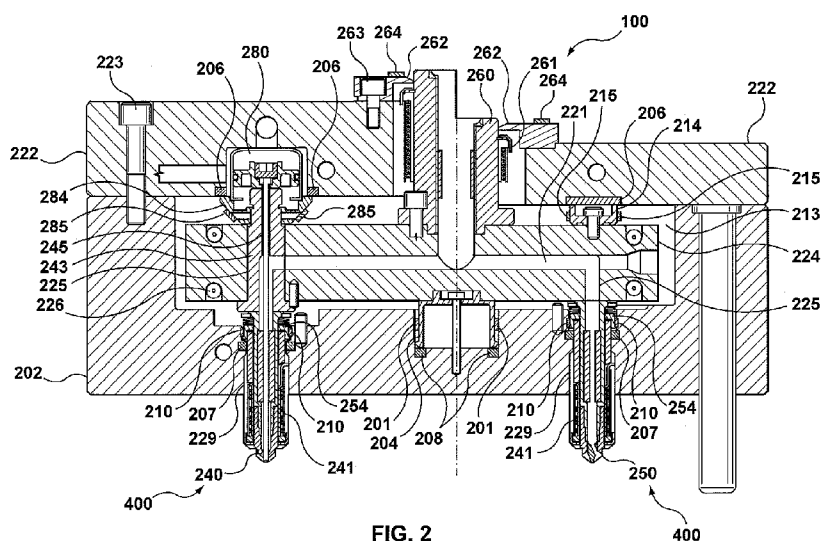
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(54) Title: HOT RUNNER WITH SUPPLEMENTAL HEATERS

**FIG. 2**

(57) Abstract: A hot runner with supplemental heating elements is disclosed. Supplemental heaters are disposed at or near interface elements that are located between heated components and corresponding non-heated component support structures. In some cases, by heating the interface element itself or by disposing a supplemental heater at an interfacing location between the interface element and the non-heated support structure or between the interface element and the heated component, thermal variation within the melt distribution portion of a hot runner may be altered for improved system performance. In some cases, such arrangements serve to replace the heat that is otherwise lost to the support structure.

HOT RUNNER WITH SUPPLEMENTAL HEATERS

FIELD

5 Aspects relate generally to injection molding systems, and more specifically to a hot runner having supplemental heaters at desired locations to alter thermal distribution for improved system performance.

BACKGROUND

10 Various types of known hot runner systems are used in injection molding machines to make molded parts. In such systems, components through which the melt travels are heated, but those components are typically supported by plates or other structures that are not heated. As a result, thermal variations within the melt distribution portion of a hot runner can occur due to heat transfer from the heated components to the non-heated support
15 plates through interface elements positioned between the heated components and the non-heated support plates.

 One known strategy to reduce heat transfer is to use low thermal conductivity, sometimes exotic, materials for the interface elements. Another known strategy is to use complex low surface area contact geometries.

20

SUMMARY

 The inventors have found that conventional hot runner systems experience heat transfer from heated components to non-heated supporting components through interfacing locations. The inventors have recognized that such heat transfer gives rise to thermal
25 variation within the melt distribution portion of a hot runner that result in decreased part quality.

 The inventors have discovered that such thermal variation may be altered for improved system performance with the use of strategically positioning supplemental heaters on or near interface elements and/or at interfacing locations. These supplemental heaters
30 may be controlled separately from the main heaters used for heating the heated component, and each supplemental may be individually controlled, separate from other supplemental heaters.

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According to one aspect, a hot runner for use in an injection molding machine is provided. The hot runner includes a heated component supported by a non-heated component support. An interface element is disposed between the heated component and the component non-heated support. A supplemental heater contacts the interface element.

5 According to another aspect, a hot runner for use with an injection molding machine is provided. The hot runner includes a heated component supported by a non-heated component support. An interface element is disposed between the heated component and the non-heated component support. The interface element interfaces with the heated component at a first interfacing location, and the interface element also interfaces with the non-heated component support at a second interfacing location. A supplemental heater is
10 disposed at the first interfacing location or at the second interfacing location.

According to another aspect, a method for use in an injection molding machine is provided. The method includes heating a component, supporting the component with at least one non-heated component support, disposing an interface element between the component and the at least one non-heated component support, and contacting a
15 supplemental heater with the interface element.

It should be appreciated that the foregoing concepts, and additional concepts discussed below, may be arranged in any suitable combination, as the present disclosure is not limited in this respect.

20 The foregoing and other aspects, embodiments, and features of the present teachings can be more fully understood from the following description in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

25 The accompanying drawings are not intended to be drawn to scale. In the drawings, each identical or nearly identical component that is illustrated in various figures is represented by a like numeral. For purposes of clarity, not every component may be labeled in every drawing. Various embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

30 FIG. 1 is a cross-sectional view of an example of a prior art hot runner;

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FIG. 2 is a cross-sectional view of an example of a hot runner with supplemental heaters disposed on interface elements according to one illustrative embodiment; and

FIG. 3A is a cross-sectional view of an example of a hot runner with supplemental heaters disposed at interfacing locations according to another illustrative embodiment.

5 FIGS. 3B-3U are schematics showing different arrangements with supplemental heaters disposed at interfacing locations according to various embodiments.

DETAILED DESCRIPTION

As discussed above, conventional hot runners for use in injection molding machines
10 include melt channels disposed within heated components that are supported by non-heated support structures or plates. Interface elements such as standoffs and other support elements are typically disposed in contact with and between the heated component(s) and the corresponding non-heated support plates. Since the heated components are generally at a temperature higher than the non-heated component support plates, heat tends to transfer
15 along a temperature gradient from the heated components to the non-heated component support plates through the interface elements, giving rise to thermal variation along melt channels and resulting in decreased part quality.

As used herein, a “heated component” includes any component in the hot runner that is directly contacted by a heater and that contacts the melt. A “heated component” may
20 include, but is not limited to, the manifold, manifold bushing, nozzle assembly, nozzle tip and the sprue bushing.

As also used herein, a “non-heated component support” includes any component in the hot runner that supports another component and does not contact the melt. In some cases, the non-heated component support may support a heated component. A “non-heated
25 component support” may include, but is not limited to, a manifold backing plate, a manifold plate, or any other support plate. In some cases, non-heated component supports may be heated. For example, manifold support plates may be “heated” by “cooling water” that is at a temperature warmer than ambient temperature. Such manifold support plates are still referred to as “non-heated component supports.”

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As also used herein, an “interface element” includes any component in the hot runner that is positioned between a heated component and a component support plate, such as, but not limited to, standoffs and support elements.

Conventional hot runners seek to reduce heat transfer from the heated components to the non-heated component support plates by using interface elements and/or load-bearing inserts composed of low thermal conductivity, sometimes exotic, materials and/or by using complex low surface area contact geometries. For example, FIG. 1 shows a hot runner 100 known in the prior art. Melt travels through a sprue bushing 260 into the input of a manifold 224. The manifold 224 includes or defines one or more melt channel(s) 221 configured to convey the melt from the manifold input to the manifold output, which is usually called a drop 225. FIG. 1 depicts the manifold 224 having two drops 225, and it will be appreciated that the manifold 224 may have a single drop or may have multiple drops. A nozzle assembly 400, which is operatively connected with the drop 225 of the manifold, receives the melt from the drop 225. FIG. 1 depicts two examples of the nozzle assembly 400, which are a valve-type nozzle 240, and a thermal-type nozzle 250, though it is conventional that only one type of valve arrangement is typically used in a particular hot runner such that FIG. 1 is for illustrative purposes only.

As is well known, the nozzle assembly 400 is a heated component that is heated by nozzle assembly heater 241, manifold 224 is a heated component that is heated by manifold heater 226, and sprue bushing 260 is also a heated component that is heated by sprue bushing heater 261.

The manifold 224 is supportively received in the manifold pocket 213 that is formed by a manifold-backing plate 222 coupled to a manifold plate 202 (preferably by fasteners, such as fastener 223). Manifold plate 202 and/or manifold-backing plate 222 may be made from a low-strength steel alloy. The nozzle assembly 400 is supportively received in the nozzle hole 229 of the manifold plate 202, with support element 254 serving as an interface element between heated nozzle assembly 400 and non-heated manifold plate 202.

First load-bearing insert 207, which is located between support element 254 and non-heated manifold plate, may be made from a thermally insulating material such as ceramic to reduce heat transfer from the nozzle assembly 400 to the manifold plate 202. Manifold

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stand-off 214 and actuator stand-off 284, which both serve as interface elements between heated manifold 224 and non-heated manifold-backing plate 222, are also made from heat-insulating and/or low thermal conductivity materials as well.

Aspects are directed to a hot runner which is configured to alter thermal distribution along melt channels for improved system performance with the use of strategically positioned supplemental heaters. In some cases, by disposing a supplemental heater at the touch points, that is on the interface element itself or by disposing a supplemental heater at an interfacing location between the interface element and the non-heated support plate or between the interface element and the heated component, the thermal distribution along melt channels can be altered for improved system performance. In some cases, such arrangements may serve to replace the heat that is otherwise lost to the support plate.

FIG. 2 depicts an embodiment in which supplemental heaters are disposed on interface elements that are located between the heated components and the non-heated component support plates. In some embodiments, the supplemental heater contacts only the interface element such that the supplemental heater is spaced from the heated component and the non-heated component support plate.

FIG. 2 depicts a cross-sectional view of an example of a hot runner 100. It will be appreciated that the hot runner 100 includes components that are known to those skilled in the art, and these known components will not be described here; these known components are described, at least in part, in U.S. Patent No. 8,142,183 to Jenko, which is hereby incorporated by reference herein.

Similar to FIG. 1, FIG. 2 also depicts two examples of the nozzle assembly 400, which are a valve-type nozzle 240, and a thermal-type nozzle 250, though it is conventional that only one type of valve arrangement is typically used in a particular hot runner such that FIG. 2 is for illustrative purposes only.

As shown in FIG. 2, hot runner 100 includes many of the same components depicted in FIG. 1 and described above. The hot runner 100 includes a sprue bushing 260 heated by sprue bushing heater 261, a manifold 224 heated by manifold heater 226, and nozzle assemblies 400 heated by nozzle assembly heaters 241. The manifold plate 202 and the manifold-backing plate 222 are coupled together to define a manifold pocket 213, and the

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manifold 224 is supportively received in the manifold pocket 213. The manifold 224 receives melt from the sprue bushing 260, conveys the melt through the manifold via one or more melt channel(s) 221, which guide the melt through drops 225 into the nozzle assemblies 400. FIG. 2 depicts the manifold 224 having two drops 225, and it will be appreciated that the manifold 224 may have a single drop or may have multiple drops (or outputs).

The hot runner 100 further includes a manifold stand-off 204 which serves as an interface element between the manifold 224 and the manifold plate 202, as the manifold stand-off 204 is located between the manifold 224 and the manifold plate 202. In some cases, a manifold load-bearing insert 208 may be located between the manifold stand-off 204 and the manifold plate 202. In such cases, the manifold stand-off 204 may transmit load from the manifold 224 to the load-bearing insert 208. In some embodiments, a supplemental heater 201 is disposed on manifold stand-off 204 and heats the manifold stand-off 204. In some embodiments, the supplemental heater 201 contacts only the manifold stand-off 204 such that the supplemental heater 201 is spaced from the manifold 224 and/or the manifold plate 202.

Nozzle assembly 400 is supported by manifold plate 202. A support element 254 serves as an interface element between manifold plate 202 and nozzle assembly 400. In some cases, a first load-bearing insert 207 may be located between the support element 254 and the manifold plate 202. In such cases, the support element 254 may transmit load from the nozzle assembly 400 to the load-bearing insert 207. In some embodiments, a supplemental heater 210 is disposed on support element 254 and heats the support element 254. In some embodiments, the supplemental heater 210 contacts only the support element such that the supplemental heater 210 is spaced from the nozzle assembly 400 and/or the manifold plate 202.

Some embodiments may include a valve-type nozzle 240, as shown on the left-hand side of FIG. 2. The valve-type nozzle 240 is in fluid communication with a manifold bushing 243 that is received in the manifold 224. The manifold bushing 243 forms part of the melt channel 221 of the manifold 224. The valve-type nozzle 240 also includes a valve stem 245 that is coupled with a valve actuator 280. Various types of actuators may be used

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to reciprocate the valve stem 245 as needed, including, but not limited to: pneumatic actuators, plate actuators, electrical actuators, or mechanical actuators.

The valve-type nozzle 240 includes an actuator stand-off 284 which serves as an interface element between the manifold-backing plate 222 and the manifold 224, as the
5 actuator stand-off 284 is located between the manifold-backing plate 222 and the manifold 224. In some cases, a second load-bearing insert 206 may be located between the manifold-backing plate 222 and the actuator stand-off 284. In such cases, the actuator stand-off 284 may transmit load to the load-bearing insert 206. In some embodiments, a supplemental heater 285 is disposed on the actuator stand-off 284 and heats the actuator stand-off 284. In
10 some embodiments, the supplemental heater 285 contacts only the actuator stand-off 284 such that the supplemental heater 285 is spaced from the manifold 224 and/or the manifold-backing plate 222.

Some embodiments may include a thermal-type nozzle 250, as shown on the right-hand side of FIG. 2. Unlike the valve-type nozzle 240, the thermal-type nozzle 250 does not
15 require a valve actuator. Thus, instead of an actuator stand-off, a manifold stand-off 214 is employed to serve as an interface element between the manifold 224 and the manifold-backing plate 222, as the manifold stand-off 214 is located between the manifold 224 and the manifold-backing plate 222. In some cases, a second load-bearing insert 206 may be located between the manifold-backing plate 222 and the manifold stand-off 214. In such
20 cases, the manifold stand-off 214 may transmit load to the load-bearing insert 206. In some embodiments, as shown in FIG. 2, a supplemental heater 215 is disposed on the manifold stand-off 214 and heats the manifold stand-off 214. In some embodiments, the supplemental heater 215 contacts only the manifold stand-off 214 such that the supplemental heater 215 is spaced from the manifold 224 and/or the manifold-backing plate 222.

The sprue bushing 260 is supported by a sprue bushing support 262, which serves as
25 an interface element between the manifold-backing plate 222 and the sprue bushing 260, as the sprue bushing support 262 is located between manifold-backing plate 222 and sprue bushing 260. A sprue bushing fastener 263 couples or connects the sprue bushing support 262 with the manifold-backing plate 222. In some embodiments, a supplemental heater 264
30 is disposed on sprue bushing support 262 and heats the sprue bushing support 262. In some

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embodiments, the supplemental heater 264 contacts only the sprue bushing support 262 such that the supplemental heater 264 is spaced from the sprue bushing 260 and/or the manifold-backing plate 222.

The above embodiments described with regard to FIG. 2 include supplemental
5 heaters that are disposed on interface elements to heat the interface elements themselves. Rather than heating the interface element by disposing a supplemental heater thereon, in some embodiments, the supplemental heaters are disposed at interfacing locations between the interface element and the heated component and/or between the interface element and the non-heated component support plate.

10 One such embodiment is shown in FIG. 3A, which depicts a cross-sectional view of an example of a hot runner 100. A first interfacing location exists where the manifold stand-off 204 interfaces with the manifold 224, and a second interfacing location exists where the manifold stand-off 204 interfaces with the manifold plate 202. In the embodiment shown in FIG. 3A, a supplemental heater 203 is located at and heats the first interfacing location
15 where the manifold stand-off 204 interfaces with the manifold 224. Alternatively or in addition, a supplemental heater may be located at the second interfacing location where the manifold stand-off 204 interfaces with the manifold plate 202.

As discussed above, the support element 254 serves as an interface element between manifold plate 202 and nozzle assembly 400. A first interfacing location exists where the
20 support element 254 interfaces with the nozzle assembly 400, and a second interfacing location exists where the support element 254 interfaces with the manifold plate 202. In the embodiment shown in FIG. 3A, a supplemental heater 211 is located at and heats the first interfacing location where the support element 254 interfaces with the nozzle assembly 400. Alternatively or in addition, a supplemental heater may be located at the second interfacing
25 location where the support element 254 interfaces with the manifold plate 202.

In embodiments with a valve-type nozzle 240, as shown in the left-hand side of FIG. 3A, an actuator stand-off 284 serves as an interface element between the manifold-backing plate 222 and the manifold 224. A first interfacing location exists where the actuator stand-off 284 interfaces with the manifold 224, and a second interfacing location exists where the
30 actuator stand-off 284 interfaces with the manifold-backing plate 222. In the embodiment

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shown in FIG. 3A, a supplemental heater 286 is located at and heats the first interfacing location where the actuator stand-off 284 interfaces with the manifold 224. Alternatively or in addition, a supplemental heater may be located at the second interfacing location where the actuator stand-off 284 interfaces with the manifold-backing plate 222.

5 In embodiments with a thermal-type nozzle 250, as shown in the right-hand side of FIG. 3A, a manifold stand-off 214 serves as an interface element between the manifold 224 and the manifold-backing plate 222, as previously discussed. A first interfacing location exists where the manifold stand-off 214 interfaces with the manifold 224, and a second interfacing location exists where the manifold stand-off 214 interfaces with the manifold-backing plate 222. In the embodiment shown in FIG. 3A, a supplemental heater 216 is
10 located at and heats the first interfacing location where the manifold stand-off 214 interfaces with the manifold 224. Alternatively or in addition, a supplemental heater may be located at the second interfacing location where the manifold stand-off 214 interfaces with the manifold-backing plate 222.

15 The hot runner 100 also includes a sprue bushing 260. In the embodiment shown in FIG. 3A, a supplemental heater 217 is located at and heats the first interfacing location where the sprue bushing support 262 interfaces with the sprue bushing 260. Alternatively or in addition, a supplemental heater may be located at the second interfacing location where sprue bushing support 262 interfaces with the manifold-backing plate 222.

20 It should be appreciated that this aspect is not limited to the interfacing locations of the supplemental heaters depicted in FIG. 3A. Supplemental heaters may be located at interfacing locations in a variety of different arrangements, as shown in FIGS. 3B-3U, as will be discussed.

 As used herein, "interface" is not necessarily limited to direct contact. For example,
25 an interface element may interface with a heated component even if a heater is positioned between the two components such that the two components do not directly contact one another. An interfacing location between two components may be characterized as an area where the two components meet, and the general vicinity surrounding such an area.

 FIGS. 3B-3U are schematics that depict a variety of different arrangements in which
30 a supplemental heater is disposed at an interfacing location. FIGS. 3B-3U depict a heated

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component 510, a non-heated component support plate 500, an interface element 520, and a supplemental heater 530. As shown schematically in FIGS. 3B-3U, heated component 510 is heated with a heater 515. FIGS. 3B-3M depict a first interfacing location 550 between the heated component 510 and the interface element 520, and a second interfacing location 560
5 between the interface element 520 and the non-heated component support plate 500.

In some embodiments, as shown schematically in FIGS. 3B-3E, supplemental heater 530 may be disposed at the first interfacing location 550 in a number of different arrangements. In each of FIGS. 3B-3E, a supplemental heater 530 is positioned between at least a portion of the interface element 520 and at least a portion of the heated component
10 510. In one embodiment, shown in FIG. 3B, supplemental heater 530 is sandwiched between heated component 510 and interface element 520. In one embodiment, shown in FIG. 3C, supplemental heater 530 is located within or otherwise in contact with interface element 520 and is in contact with heated component 510. For example, interface element 520 may include a groove or cavity within which supplemental heater 530 is located. In one
15 embodiment, shown in FIG. 3D, supplemental heater 530 is located within or otherwise in contact with heated component 510 and is in contact with interface element 520. For example, heated component 510 may include a groove or cavity within which supplemental heater 530 is located. In one embodiment, shown in FIG. 3E, supplemental heater 530 is located within and in contact with both heated component 510 and interface element 520.
20 For example, heated component 510 and interface element 520 may each include a groove or cavity within which supplemental heater 530 is located.

In some embodiments, as shown schematically in FIGS. 3F-3I, supplemental heater 530 may be disposed at the second interfacing location 560 in a number of different arrangements. In each of FIGS. 3F-3I, a supplemental heater 530 is positioned between at least a portion of the interfacing element 520 and at least a portion of the component support
25 plate 500. In one embodiment, shown in FIG. 3F, supplemental heater 530 is sandwiched between component support plate 500 and interface element 520. In one embodiment, shown in FIG. 3G, supplemental heater 530 is located within or otherwise in contact with interface element 520 and is in contact with component support plate 500. For example,
30 interface element 520 may include a groove or cavity within which supplemental heater 530

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is located. In one embodiment, shown in FIG. 3H, supplemental heater 530 is located within or otherwise in contact with component support plate 500 and is in contact with interface element 520. For example, component support plate 500 may include a groove or cavity within which supplemental heater 530 is located. In one embodiment, shown in FIG. 3I, supplemental heater 530 is located within or otherwise in contact with both component support plate 500 and interface element 520. For example, component support plate 500 and interface element 520 may both include a groove or cavity within which supplemental heater 530 is located.

In some embodiments, as shown schematically in FIGS. 3J-3K, a supplemental heater 530 may be placed in contact with an end 600 of the interface element 520. In one embodiment, shown in FIG. 3J, a supplemental heater 530 is disposed at the first interfacing location 550 at the end of the interface element 520. Alternatively or in addition, though not shown, the supplemental heater 530 may be disposed at the end 600 of the heated component 510. In one embodiment, shown in FIG. 3K, a supplemental heater 530 is disposed at the second interfacing location 560 at the end 600 of interface element 520. Alternatively or in addition, also not shown, the supplemental heater 530 may be disposed at the end of the component support plate 500.

In some embodiments, as shown schematically in FIGS. 3L-3M, a supplemental heater may be located entirely within the heated component or the component support plate and spaced from the interface element. In some embodiments, shown in FIG. 3L, a supplemental heater 530 is located entirely within heated component 510. For example, heated component 510 may include a cavity within which supplemental heater 530 is located. Although the supplemental heater 530 is not in direct contact with the interface element 520, the supplemental heater 530 is still disposed at the first interfacing location 550 and serves to heat the first interfacing location 550. In one embodiment, shown in FIG. 3M, a supplemental heater 530 is located entirely within component support plate 500. For example, component support plate 500 may include a cavity within which supplemental heater 530 is located. Although the supplemental heater 530 is not in direct contact with the interface element 520, the supplemental heater 530 is still disposed at the second interfacing location 560 and serves to heat the second interfacing location 560.

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In some embodiments, as shown schematically in FIGS. 3N-3O, a heated component and a component support plate may interface with one another directly without an interface element in-between. In each of FIGS. 3N-3O, a heated component 530 is between at least a portion of heated component 510 and component support plate 500. In FIGS. 3N-3O, an
5 interfacing location 570 exists between heated component 510 and component support plate 500. In one embodiment, as shown in FIG. 3N, a supplemental heater 530 may be located within both heated component 510 and component support plate 500. For example, heated component 510 and component support plate 500 may both include a groove or cavity within which supplemental heater 530 is located. In one embodiment, as shown in FIG. 3O,
10 a supplemental heater 530 may be sandwiched directly between the heated component 510 and the component support plate 500.

In some embodiments, as shown schematically in FIGS. 3P-3Q, a supplemental heater may be located on the edge of a heated component or a component support plate. The supplemental heater may be spaced from the interface element, or it may contact the
15 interface element. In one embodiment, shown in FIG. 3P, the supplemental heater 530 is positioned on the edge of heated component 510. Although the supplemental heater 530 is not in direct contact with the interface element 520, the supplemental heater 530 is still disposed at the first interfacing location 550 and serves to heat the first interfacing location 550. In one embodiment, the supplemental heater 530 is an edge heater that is located on
20 the edge of a manifold. In one embodiment, shown in FIG. 3Q, the supplemental heater is positioned on the edge of component support plate 500. Although the supplemental heater 530 is not in direct contact with the interface element 520, the supplemental heater 530 is still disposed at the second interfacing location 560 and serves to heat the second interfacing location 560.

25 In some embodiments, as shown schematically in FIGS. 3R-3S, a supplemental heater may be disposed on the surface of a heated component and spaced from an interface element. In one embodiment, shown in FIG. 3R, the supplemental heater 530 is disposed on the surface of heated component 510 and spaced from both the interface element 520 and the component support plate 500. Although the supplemental heater 530 is not in direct contact
30 with the interface element 520, the supplemental heater 530 is still disposed at the first

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interfacing location 550 and serves to heat the first interfacing location 550. As shown in FIG. 3S, which is a cross-sectional view of FIG. 3R, the supplemental heater 530 may be a ring shaped heater that encircles, but does not contact, the interface element 520. In one embodiment, the supplemental heater is a plasma heated ring. In some embodiments, the supplemental heater 530 is disposed on the surface of the component support plate and spaced from both the interface element 520 and the heated component 510. Although the supplemental heater 530 is not in direct contact with the interface element 520, the supplemental heater 530 is still disposed at the second interfacing location 560 and serves to heat the second interfacing location 560.

In one embodiment, as shown in FIG. 3T, a supplemental heater 530 such as a supplemental tubular heater is embedded within a manifold 224, and the supplemental heater 530 may be separately controlled from the manifold heater 226.

In one embodiment, as shown in FIG. 3U, a supplemental heater 530 is located on the edge of manifold 224, and the supplemental heater 530 may be separately controlled from the manifold heater 226.

Supplemental heaters can be coiled heaters, film heaters, thermoelectric heaters, band heaters, electrical resistive heaters, cable heaters, cartridge heaters, tubular heaters, aluminum nitride heaters, ceramic heaters, plasma or other layered heater, or any other suitable type of heater, as this aspect is not so limited.

The supplemental heaters may be controlled separately from the main heaters that is used to heat the heated component, and each supplemental may be individually controlled, independent of other supplemental heaters. Of course, in other embodiments, a supplemental heater may be controlled along with the main heaters for the heated components and/or along with other supplemental heaters. The independent temperature control may be achieved by providing a temperature sensing device such as a thermocouple at each supplemental heater, and wiring each supplemental heater and thermocouple to a power source/controller which supplies power to the supplemental heaters and reads the information supplied by the thermocouples.

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Other features of a conventional hot runner may be used in connection with the hot runner discussed herein. Such additional features will be readily apparent to one of skill in the art.

It should be appreciated that the invention is not limited to any particular object or purpose. It should also be appreciated that the hot runner described here may be formed with one or more of the above-described features. The above aspects and features may be employed in any suitable combination as the present invention is not limited in this respect. It should also be appreciated that the drawings illustrate various components and features which may be incorporated into various embodiments of the invention. For simplification, some of the drawings may illustrate more than one optional feature or component. However, the invention is not limited to the specific embodiments disclosed in the drawings. It should be recognized that some embodiments may include only a portion of the components illustrated in any one drawing figure, and/or may also encompass embodiments combining components illustrated in multiple different drawing figures.

It should be understood that the foregoing description of various embodiments of the invention are intended merely to be illustrative thereof and that other embodiments, modifications, and equivalents of the invention are within the scope of the invention recited in the claims appended hereto.

What is claimed is:

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CLAIMS

1. A hot runner for use in an injection molding machine, the hot runner comprising:
a heated component;
at least one non-heated component support that supports the heated component;
5 an interface element disposed between the heated component and the at least one non-heated component support; and
a supplemental heater contacting the interface element.
2. The hot runner of claim 1, wherein the supplemental heater is spaced from the heated
10 component or the at least one non-heated component support.
3. The hot runner of claim 1, wherein the supplemental heater is spaced from the heated component and from the at least one non-heated component support.
- 15 4. The hot runner of claim 1, wherein the supplemental heater is positioned between at least a portion of the interface element and at least a portion of the heated component.
5. The hot runner of claim 1, wherein the supplemental heater is positioned between at least a portion of the interface element and at least a portion of the at least one non-heated
20 component support.
6. The hot runner of claim 1, further comprising:
a main heater that heats the heated component; and
a controller that controls the supplemental heater, wherein the supplemental heater is
25 controlled separately from the main heater.
7. The hot runner of claim 6, further comprising:
a second supplemental heater contacting a second interface element, wherein the supplemental heater is controlled separately from the second supplemental heater.
30
8. A hot runner for use with an injection molding machine, the hot runner comprising:

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a heated component;
at least one non-heated component support that supports the heated component; and
an interface element disposed between the heated component and the at least one
non-heated component support; and

5 a supplemental heater,
wherein the interface element interfaces with the heated component at a first
interfacing location, the interface element interfaces with the at least one non-heated
component support at a second interfacing location, and the supplemental heater is disposed
at the first interfacing location or at the second interfacing location.

10 9. The hot runner of claim 8, wherein the supplemental heater is positioned between at
least a portion of the interface element and at least a portion of the heated component.

10. The hot runner of claim 8, wherein the supplemental heater is positioned between at
15 least a portion of the interface element and at least a portion of the at least one non-heated
component support.

11. The hot runner of claim 8, wherein the supplemental heater is spaced from the
interface element and embedded in the heated component.

20 12. The hot runner of claim 8, wherein the supplemental heater is disposed in contact
with the interface element.

13. The hot runner of claim 11, further comprising:
25 a main heater that heats the heated component; and
a controller that controls the supplemental heater, wherein the supplemental heater is
controlled separately from the main heater.

14. The hot runner of claim 13, further comprising:
30 a second supplemental heater contacting a second interface element, wherein the
supplemental heater is controlled separately from the second supplemental heater.

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15. A method for use in an injection molding machine, comprising:
heating a component;
supporting the component with at least one non-heated component support;
5 disposing an interface element between the component and the at least one non-heated component support; and
contacting a supplemental heater with the interface element.

16. The method of claim 15, wherein the supplemental heater is spaced from the
10 component or the at least one non-heated component support.

17. The method of claim 15, wherein the supplemental heater is spaced from the component and from the at least one non-heated component support plate.

15 18. The method of claim 15, further comprising:
controlling the supplemental heater separately from a main heater that heats the component.

19. The method of claim 18, further comprising:
20 contacting a second supplemental heater with a second interface element; and
controlling the supplemental heater separately from a second supplemental heater.

20. The method of claim 15, further comprising positioning the supplemental heater between at least a portion of the interface element and at least a portion of the component.

25 21. The method of claim 15, further comprising positioning the supplemental heater between at least a portion of the interface element and at least a portion of the at least one non-heated component support.

1 / 8

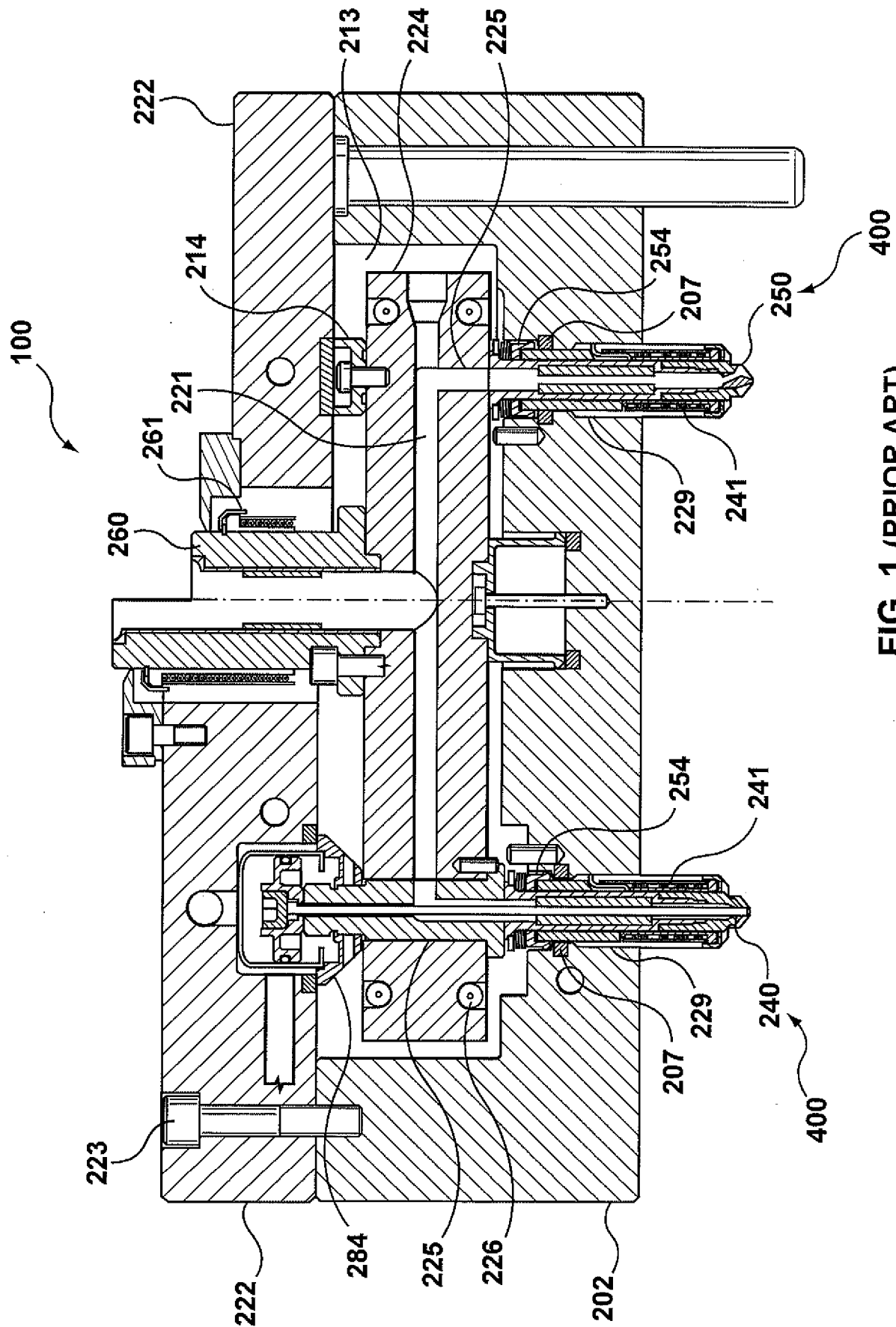


FIG. 1 (PRIOR ART)

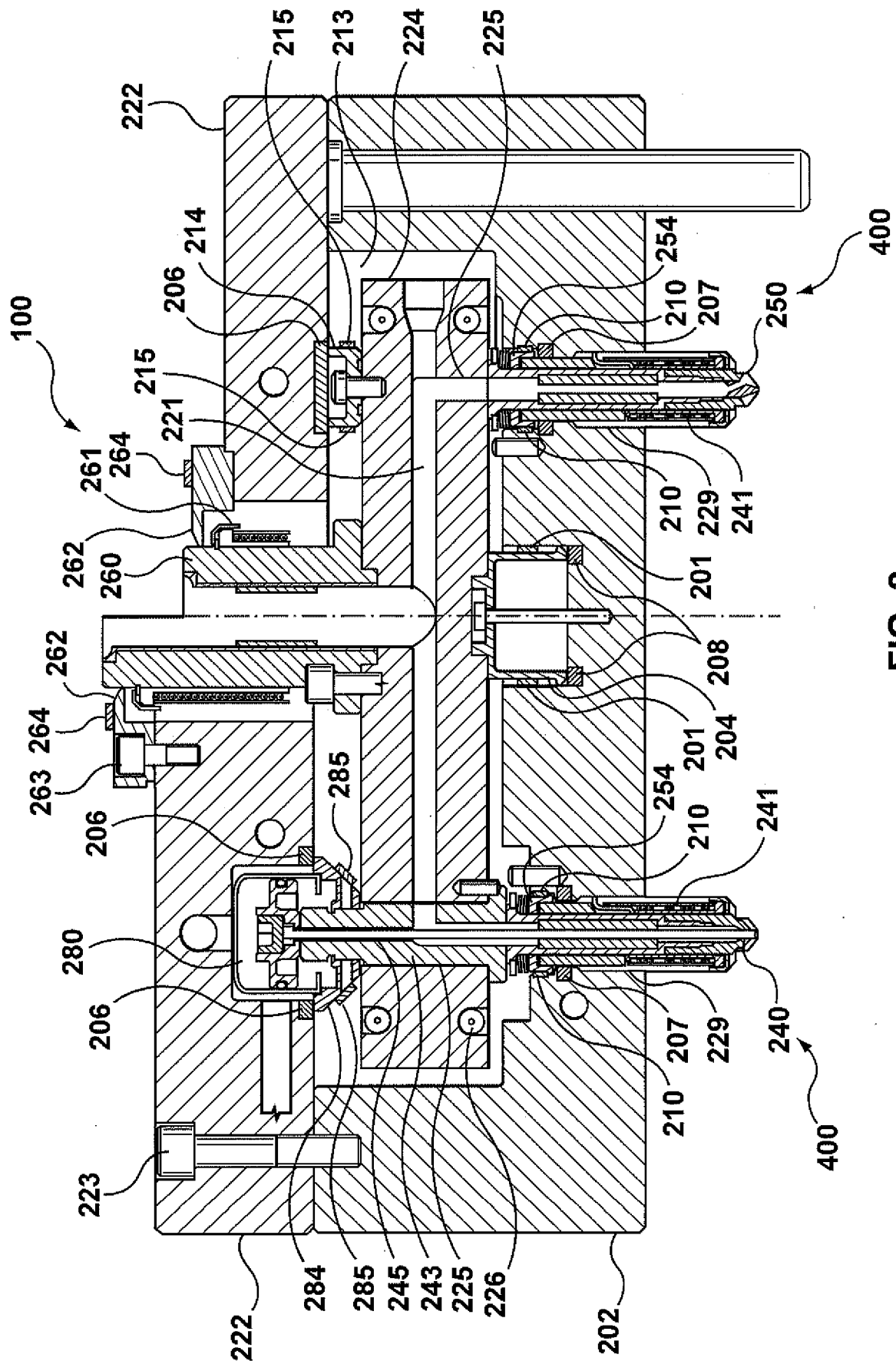


FIG. 2

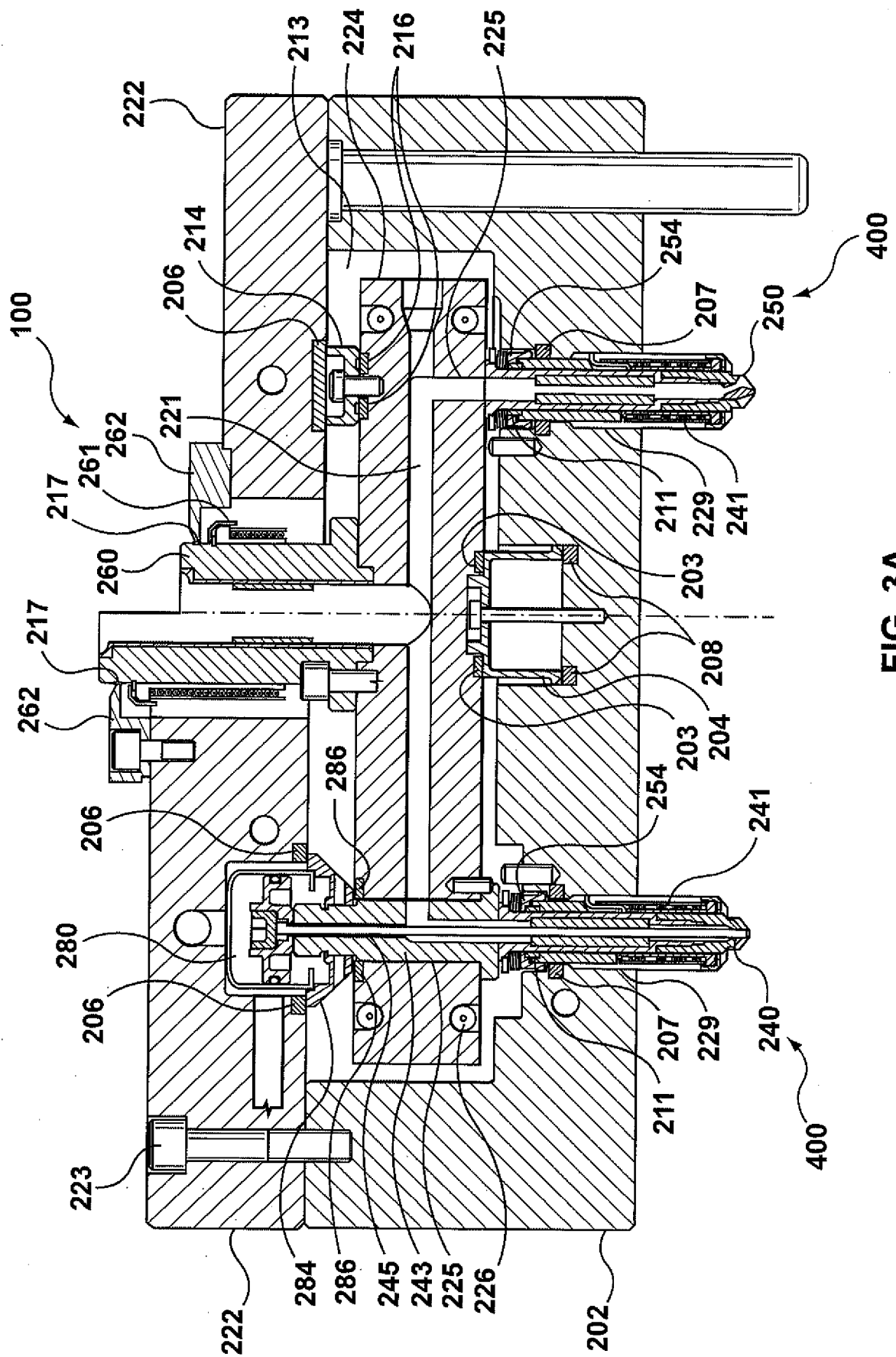


FIG. 3A

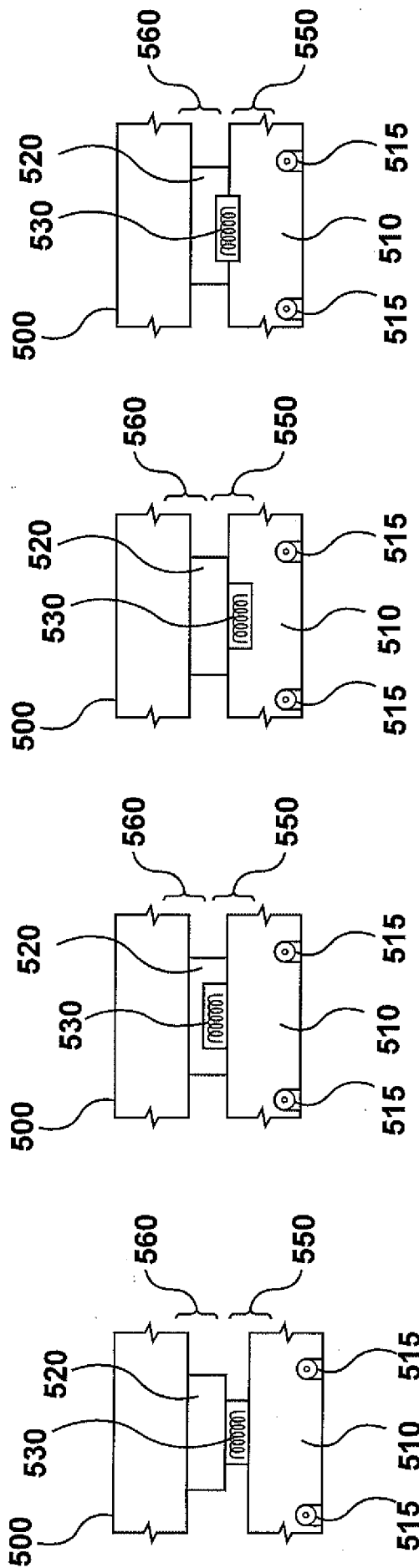


FIG. 3B

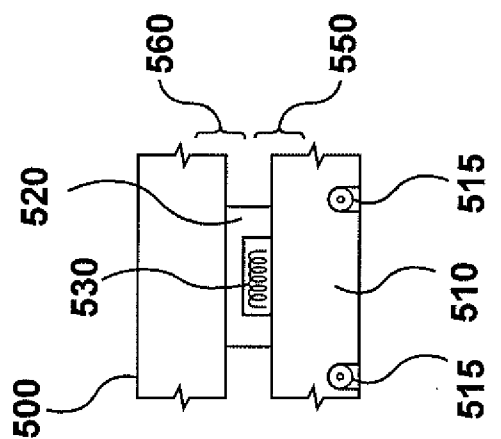


FIG. 3C

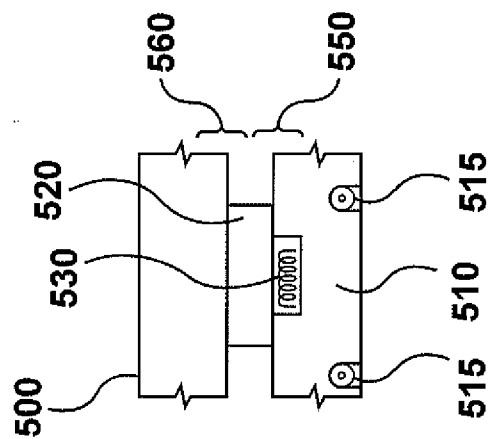


FIG. 3D

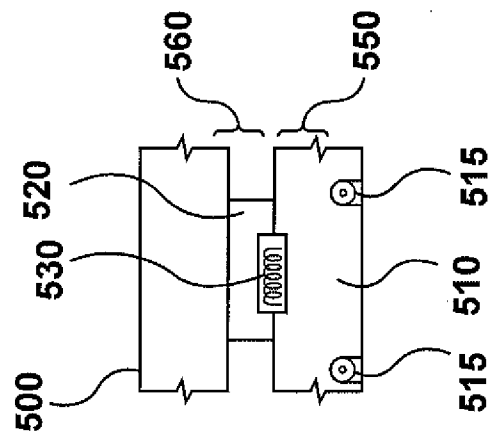


FIG. 3E

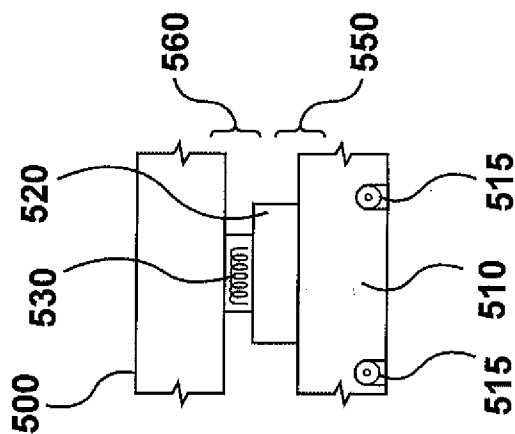


FIG. 3F

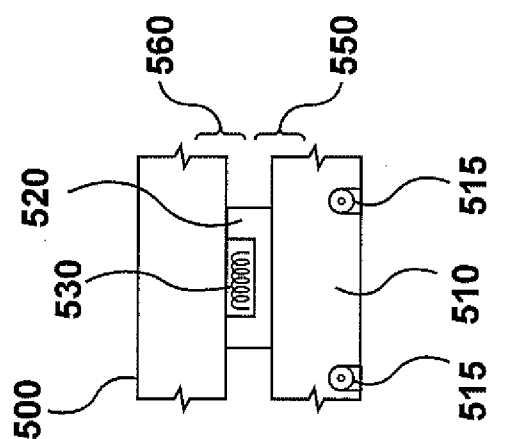


FIG. 3G

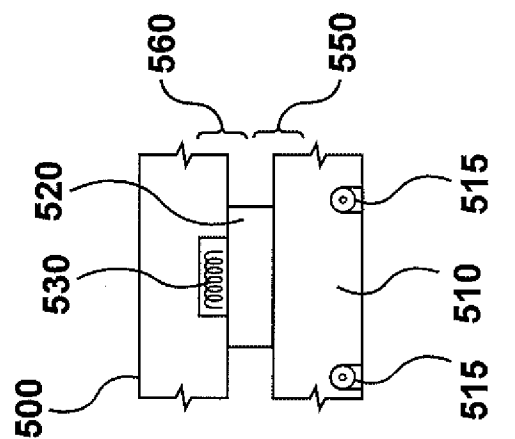


FIG. 3H

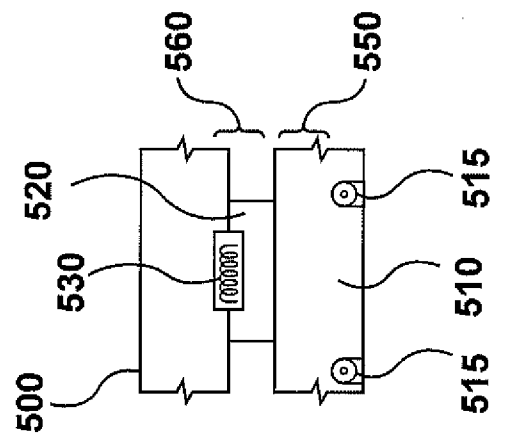


FIG. 3I

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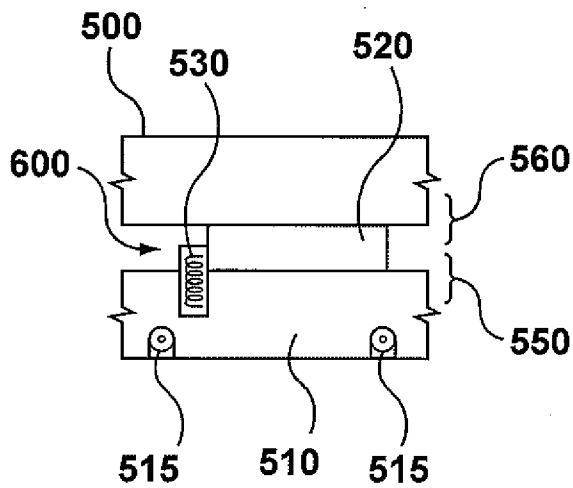


FIG. 3J

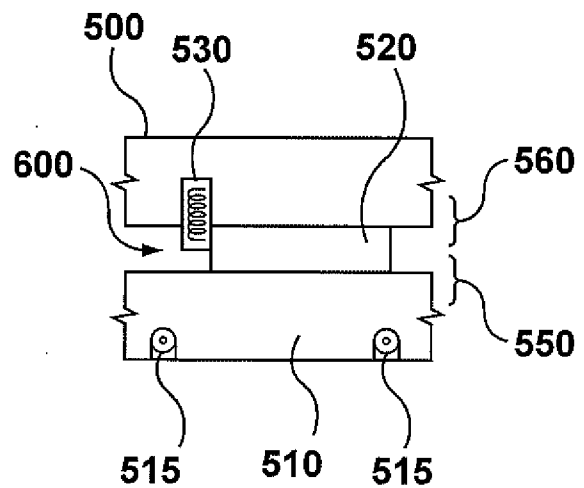


FIG. 3K

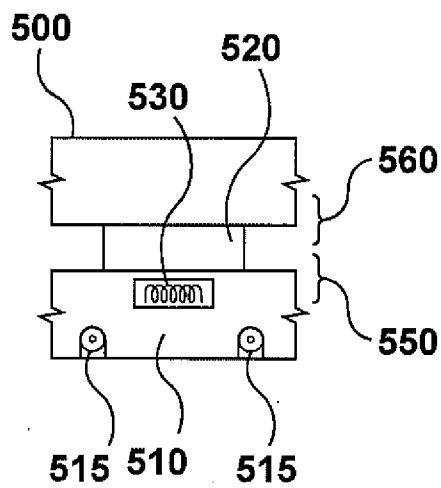


FIG. 3L

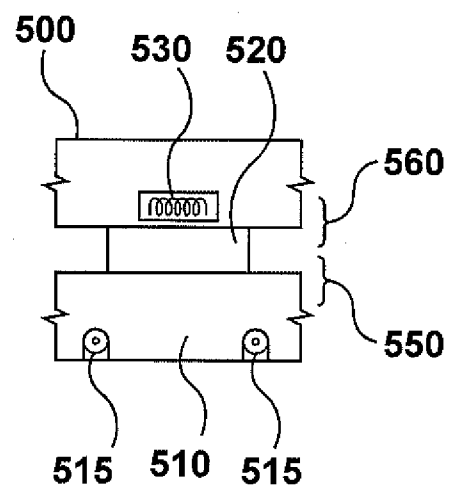


FIG. 3M

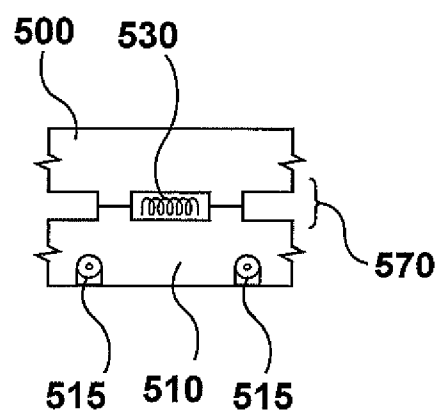


FIG. 3N

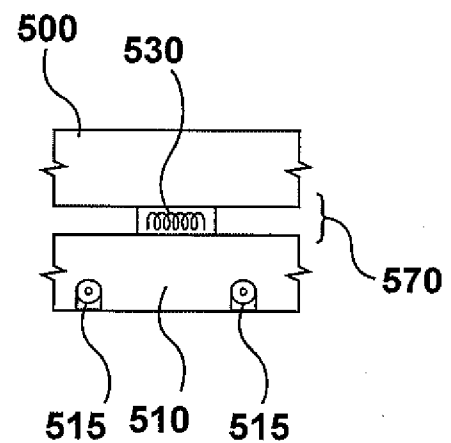
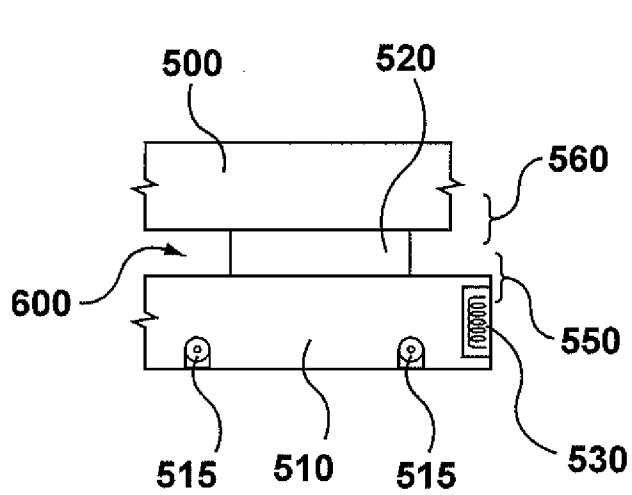
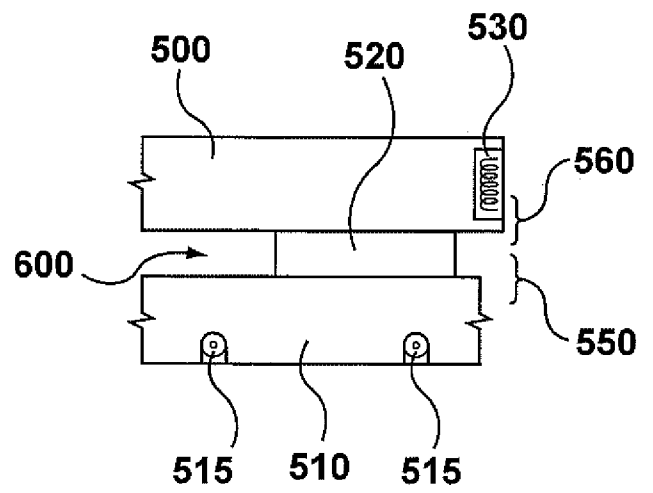
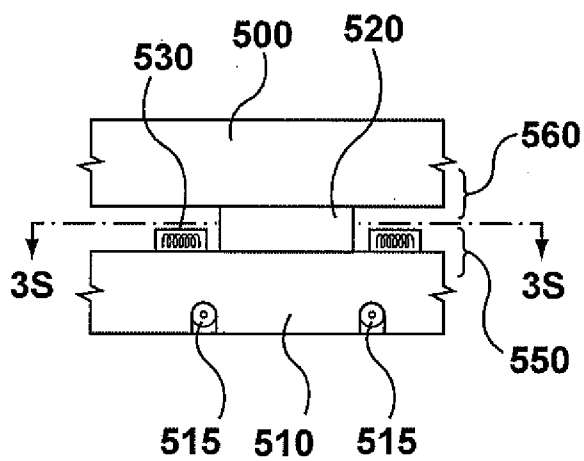
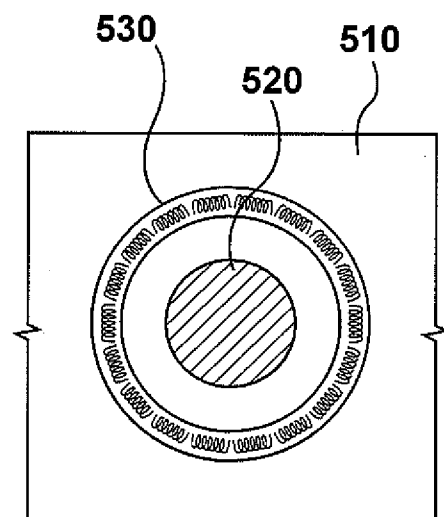


FIG. 3O

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**FIG. 3P****FIG. 3Q****FIG. 3R****FIG. 3S**

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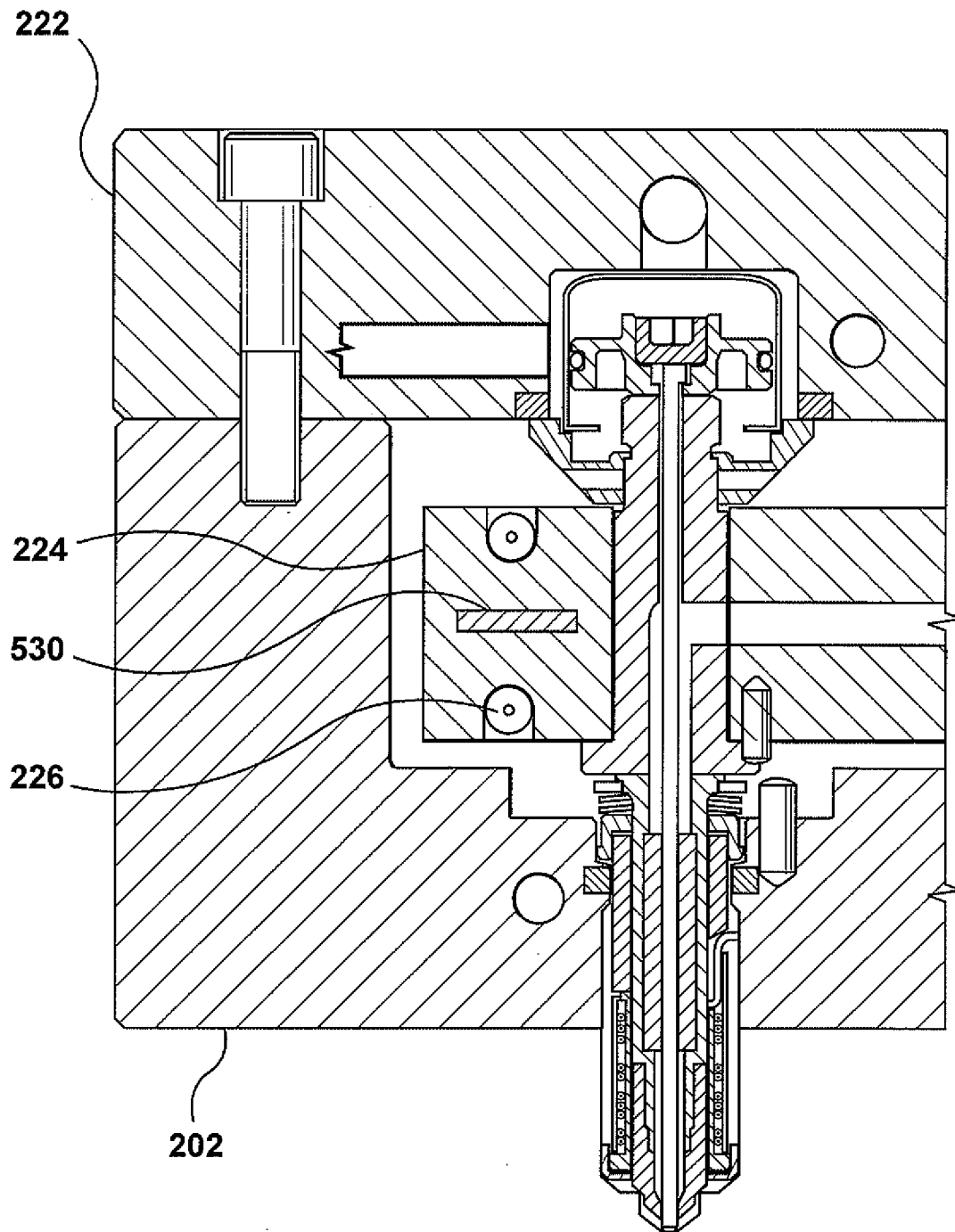


FIG. 3T

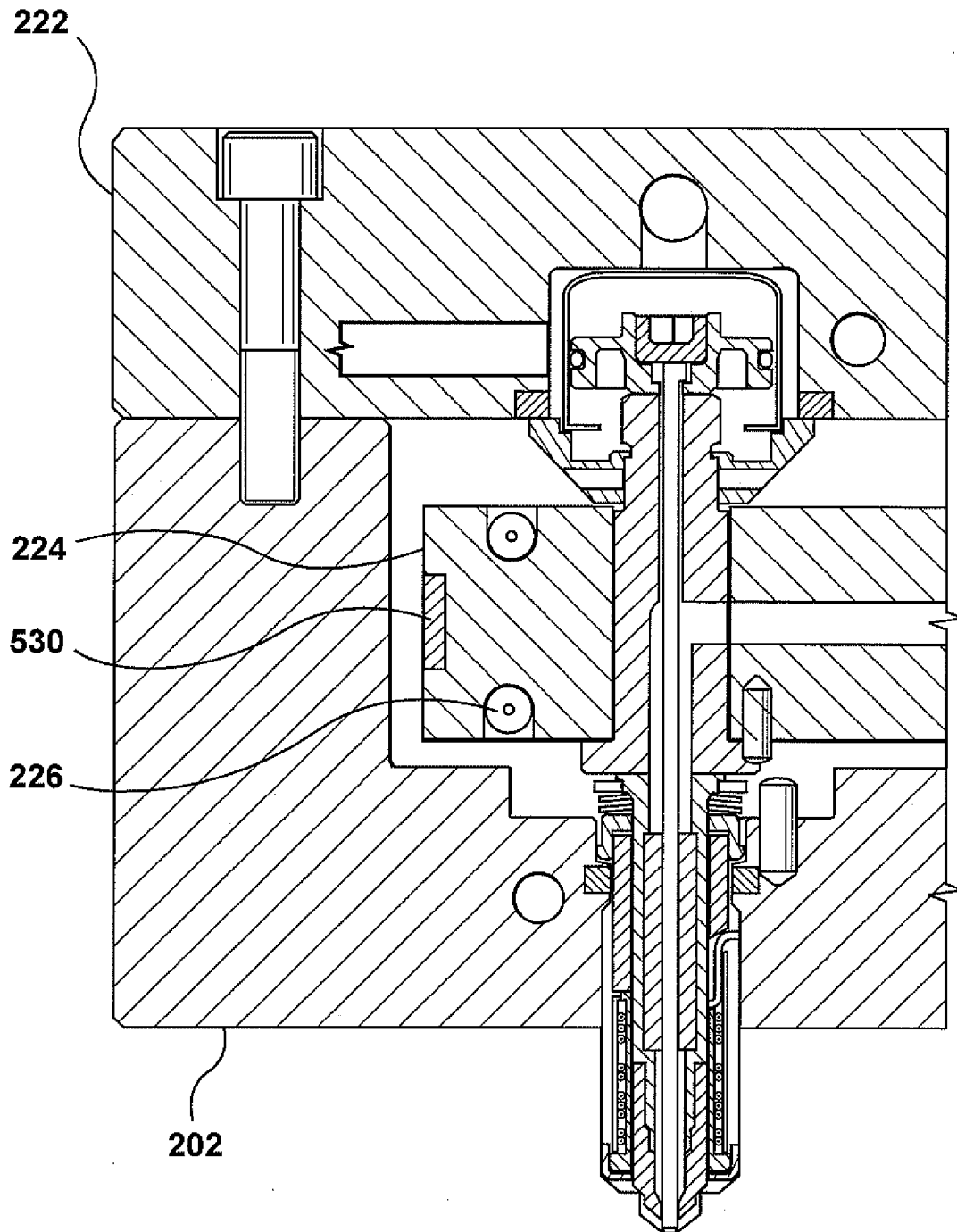


FIG. 3U

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2014/022903

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B29C 45/72 (2014.01)

USPC - 264/328.14

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(8) - B29C 45/18, 45/27, 45/72, 45/74 (2014.01)

USPC - 264/328.1, 328.14; 425/547, 567, 572

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

CPC - B29C 45/27, 45/2737, 2045/274 (2014.02)

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

PatBase, Google Patents, Google, YouTube

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,148,594 A (GELLERT) 22 September 1992 (22.09.1992) entire document	1-5, 8-10, 12, 15-17, 20, 21
—		
Y		6, 7, 11, 13, 14, 18, 19
Y	US 2005/0129801 A1 (GODWIN et al) 16 June 2005 (16.06.2005) entire document	6, 7, 11, 13, 14, 18, 19
A	US 2006/0228442 A1 (FISCHER et al) 12 October 2006 (12.10.2006) entire document	1-21

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



* Special categories of cited documents:

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"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

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search

16 June 2014

Date of mailing of the international search report

01 JUL 2014

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300

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