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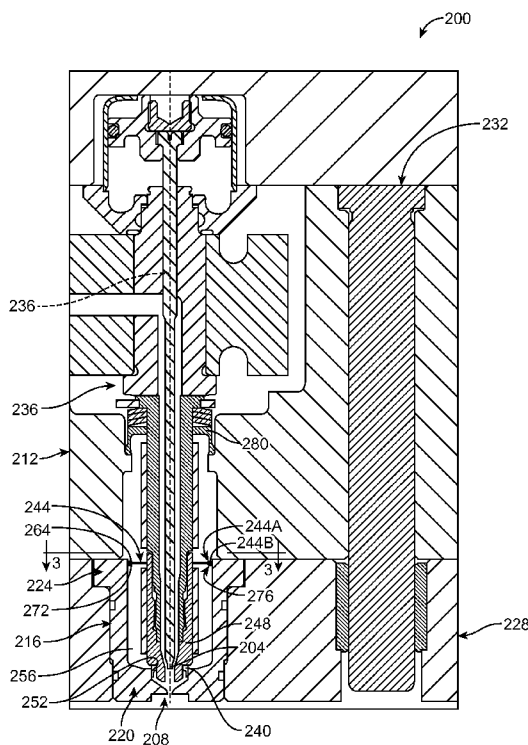


FIG. 2

(57) Abstract: An injection molding apparatus that includes a nozzle stack that achieves alignment of its valve-stem tip with a gate orifice via two primary alignment interfaces between the nozzle stack and the gate region containing the gate orifice. By keying nozzle-stack alignment off of a unitary structure, alignment errors due to cumulative locational deviations are avoided. In one example, one of the primary alignment interfaces is provided by a seal ring that is sealingly engaged between the nozzle stack and the gate region proximate to the gate orifice. In that example, the second one of the primary alignment interfaces is located distally from the gate orifice and includes first and second alignment features on the nozzle stack and the gate region, respectively, that engage one another to effect the desired valve-stem-tip/gate orifice alignment.



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GATE-ALIGNED NOZZLE STACK FOR INJECTION-MOLDING APPARATUS

FIELD OF THE INVENTION

The present invention generally relates to the field of injection molding hot runner systems. In particular, the present invention is directed to a gate-aligned nozzle stack for injection-molding apparatus.

BACKGROUND OF THE INVENTION

In valve gated hot runner injection molding, the position and alignment of the nozzle stack, valve stem, and gate insert are critically important to the performance and longevity of the valve gate shut-off. The valve stem shuttles in and out of the gate orifice to permit or preclude resin flow into the mold cavity. In order to allow the free movement of the stem into and out of the gate orifice, there is an annular gap between the stem and gate. This small gap must be precisely defined to limit the amount of resin that is trapped between the stem and gate. During de-molding of the plastic part, resin in the annular gap is disconnected from the hot runner. The portion of the trapped resin that remains on the molded part is termed "gate vestige." The amount and appearance of the vestige are important characteristics of a plastic part. Excess or unsightly vestige can lead to rejection of the molded part due to compromised plastic part function or aesthetics. Improper positioning of the components that define the annular gap can cause wear and damage to the stem and gate. This wear or damage can lead to the creation of unacceptable vestige on the molded part that, in turn, results in lost product and productivity.

SUMMARY OF THE DISCLOSURE

In one implementation, the present disclosure is directed to an injection-molding apparatus. The injection-molding apparatus includes a gate region that includes a first longitudinal axis, a gate orifice, a first nozzle stack alignment feature, and a second nozzle stack alignment feature spaced from the first nozzle stack alignment feature along the first longitudinal axis, and a nozzle stack that includes a second longitudinal axis located so as to be parallel to the first longitudinal axis of the gate region during engagement of the nozzle stack with the gate region when the injection-molding apparatus is operating; a valve member movable along the second longitudinal axis so as to be intermittently engaged with the gate orifice when the injection-molding apparatus is operating; a third nozzle stack alignment feature designed and configured to engage the first nozzle stack alignment feature; and a fourth nozzle stack alignment feature designed and configured to engage the second nozzle stack alignment feature.

In another implementation, the present disclosure is directed to a nozzle stack for use in injection-molding apparatus that includes a gate region having a first longitudinal axis and including a nozzle-receiving cavity extending along the first longitudinal axis and a gate orifice located along the first

longitudinal axis and in fluid communication with the nozzle receiving cavity, the gate region having a first alignment feature located in the nozzle-receiving cavity proximate to the gate orifice and a second alignment feature located in the nozzle-receiving cavity distal from the gate orifice. The nozzle stack includes a second longitudinal axis located so as to be parallel to the first longitudinal axis of the gate region during engagement of the nozzle stack with the gate region, a valve member movable along the second longitudinal axis so as to be intermittently engaged with the gate orifice when the injection-molding apparatus is operating, a third alignment feature designed and configured to engage the first alignment feature, and a fourth alignment feature designed and configured to engage the second alignment feature, wherein engagement of the third alignment feature with the first alignment feature and the fourth alignment feature with the second alignment feature cooperate to align the valve member with the gate orifice.

In still another implementation, the present disclosure is directed to a gate structure for use in an injection molding apparatus that includes a nozzle stack having a second longitudinal axis and including a valve member movable along the second longitudinal axis, a third alignment feature, and a fourth alignment feature. The gate structure includes a first longitudinal axis located so as to be parallel to the second longitudinal axis of the nozzle stack during engagement of the nozzle stack with the gate structure when the injection-molding apparatus is operating, a nozzle-receiving cavity extending along the first longitudinal axis, a gate orifice located along the first longitudinal axis and in fluid communication with the nozzle-receiving cavity, a first alignment feature located proximate to the gate orifice and designed and configured to engage the first alignment feature, and a second alignment feature spaced from the first nozzle stack alignment feature along the first longitudinal axis and designed and configured to engage the second alignment feature, wherein engagement of the third alignment feature with the first alignment feature and the fourth alignment feature with the second alignment feature cooperate to align the valve member of the nozzle stack with the gate orifice.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of illustrating the invention, the drawings show aspects of one or more embodiments of the invention. However, it should be understood that the present invention is not limited to the precise arrangements and instrumentalities shown in the drawings, wherein:

FIG. 1 is a cross-sectional partial view of a conventional injection-molding apparatus;

FIG. 2 is a cross-sectional partial view of an exemplary injection-molding apparatus that includes a valve-stem-tip/gate-interface alignment system made in accordance with the present invention;

FIG. 3 is an enlarged cross-sectional view as taken along line 3-3 of FIG. 2;

FIG. 4 is a cross-sectional partial view of another exemplary injection molding apparatus that includes an alternative valve-stem-tip/gate-interface alignment system made in accordance with the present invention;

FIG. 5 is a cross-sectional partial view of a further exemplary injection molding apparatus that includes another alternative valve-stem-tip/gate-interface alignment system made in accordance with the present invention; and

FIG. 6 is a cross-sectional view as taken along line 6-6 of FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

The present invention is directed to structures and methods for properly aligning valve stems with corresponding respective gate orifices in injection-molding apparatuses. As mentioned in the Background section above, improper alignment of the tip of a valve stem with the corresponding gate orifice can cause any one or more of various problems.

For a basic understanding of how improper alignment can arise, FIG. 1 illustrates a conventional injection-molding apparatus 10 that can have improper valve-stem-tip/gate-interface alignment due to the arrangement and locations of the nozzle stack alignment structures. While those skilled in the art will readily recognize the structures shown in FIG. 1, for the sake of completeness a brief review of various components of apparatus 10 is first presented. Apparatus includes a hot-runner manifold 12, which is located within a manifold cavity 14 defined by a manifold plate 16 and a backing plate 18. As those skilled in the art know, manifold 12 is movably mounted within cavity 14 to accommodate the thermal expansion differential that occurs between the manifold and other components, such as manifold plate 16 and backing plate 18, during use of apparatus 10 for injecting one or more molten materials (not shown) into one or more mold cavities of a mold (not shown).

Injection-molding apparatus 10 also includes a nozzle stack 20 that intermittently delivers the molten material(s) from one or more channels 12A within manifold 12 to the mold. Generally, nozzle stack 20 may be considered to include a manifold portion 22, a nozzle portion 24, an actuator portion 26, and a valve stem 28 that extends from the actuator portion to the nozzle portion. Manifold portion 22 of nozzle stack 20 is movable with the rest of manifold 12 as the manifold thermally expands and contracts relative to manifold plate 16 and nozzle portion 24 of the nozzle stack. To accommodate the relative movement, nozzle portion 24 is biased into sliding engagement with manifold portion 22 using a spring arrangement 30 that includes a spring 32 that works against a nozzle locator 34 that in turn is seated on a shoulder 36 formed within a nozzle cavity 38 of manifold plate 16. Nozzle portion 24 includes a main nozzle body 40, a nozzle tip 42 threadedly engaged with the main nozzle body, and a heater sleeve 44 surrounding the main nozzle body and a portion of the nozzle tip. Those skilled in the

art will readily appreciate that while a single nozzle stack 20 is shown, a typical injection-molding apparatus of the sort illustrated in FIG. 1 will have more than one nozzle stack.

Injection-molding apparatus 10 further includes a cavity plate 46 that forms part of the mold. Cavity plate 46 includes a cavity 48 into which a gate insert 50 is installed. Gate insert 50 defines a nozzle cavity 52 that receives part of nozzle portion 24 and includes a gate orifice 54 through which the
5 molten material(s) flow during injection molding operations. As those skilled in the art will know, valve stem 28 has a tip 56 configured to engage gate orifice 54 with a very close fit, for example on the order of 0 microns to 10 microns to temporarily stop the flow of the molten material(s) into the mold during de-molding operations. Nozzle cavity 52 has a first portion 52A of a relatively larger diameter
10 to accommodate heater sleeve 44 and other components, and a second portion of a relatively smaller diameter for snugly receiving a spacer ring 58 that is secured to nozzle tip 42.

Manifold plate 16 is aligned with cavity plate 46 via a plurality of guide-pin arrangements 60, one of which is shown in FIG. 1. Each guide-pin arrangement 60 includes a guide bushing 62 snugly engaged within an aperture 64 in cavity plate 46, an aperture 66 in manifold plate 16, and a guide pin 68 snugly
15 engaged within aperture 66 and bushing 62. With the conventional arrangement shown, those skilled in the art will readily appreciate that the alignment of nozzle tip 56 within gate orifice 54 when valve stem 28 is in its gate-closed position (not shown) is effectively established by nozzle locator 34 and spacer ring 58 and the precision of the locations of the various components of guide-pin arrangements 60 and the precision of the locations of the various features of nozzle cavity 30 in manifold plate 16, as
20 well as the second portion 52B of nozzle cavity 52 in gate insert 50. Those skilled in the art will also readily understand that these locations are subject to precision tolerances and that such tolerances are additive from gate orifice 54, through guide-pin arrangement 60 and to nozzle locator 34 in manifold plate 16.

Since the alignment of nozzle tip 56 with gate orifice 54 in this conventional arrangement is
25 established by two alignment interfaces 70 and 72 in two separate structures (manifold plate 16 and gate insert 50) that are aligned with guide-pin arrangements and since the alignment interfaces are affected by the additive locational tolerances mentioned above, those skilled in the art can readily appreciate that the degree of alignment of the nozzle tip with the gate orifice can vary a significant amount, depending on the actual locations of the various components. Indeed, experience with the
30 conventional nozzle-stack alignment features and arrangement shown in FIG. 1 reveals that there can be significant misalignment that results in accelerated wear of gate insert 50 at gate orifice 54 and/or accelerated wear of nozzle tip 42. The wear can result in poor sealing of gate orifice 54 when nozzle tip 42 is in its closed position, which in turn can result in undue amounts of vestige left on the molded item. Consequently, when misalignment occurs between gate orifice 54 and nozzle tip 42 and wear of

one or both of these parts becomes unacceptable, the affected part(s) need to be replaced. It would certainly be desirable to avoid such replacement or at least prolong the time period until such replacement is needed.

FIG. 2 illustrates an exemplary injection-molding apparatus 200 made in accordance with the present invention. As seen from comparing apparatus 200 of FIG. 2 to apparatus 10 of FIG. 1, the exemplary apparatus of FIG. 2 is identical in every aspect to the conventional apparatus of FIG. 1, except for the manner in which the valve tip 204 of FIG. 2 is aligned with corresponding gate orifice 208.

Specifically, instead of having one alignment interface in manifold plate 212 and another alignment interface in gate insert 216 in the manner of alignment interfaces 70, 72 in FIG. 1, exemplary apparatus 200 of FIG. 2 has two primary alignment interfaces 220 and 224 in the gate insert. Because alignment interfaces 220 and 224 are both in gate insert 216, the effect of accumulated discrepancies of actual locations versus design locations (though within tolerances) through the various elements and features of cavity plate 228, alignment pin arrangement 232, manifold plate 212, and nozzle stack 236.

Consequently, the likelihood of detrimental misalignment and the negative consequences of that misalignment are significantly reduced by placing primary alignment interfaces 220 and 224 at gate insert 216.

While alignment interfaces 220 and 224 can be effected in a wide variety of ways, in the example shown in FIG. 2, alignment interface 220 is effected using a seal ring 240 and alignment interface 224 is effected using a cavity locator 244. Seal ring 240 is fixedly secured to nozzle tip 248 and is configured to slidably engage a wall 252 of cavity 256 of gate insert 216 proximate to gate orifice 208 as the nozzle tip is inserted into the cavity. Seal ring 240 and wall 252 are designed and configured to provide both primary alignment interface 220 and a seal for the molding material (not shown) when valve tip 204 is withdrawn from gate orifice 208 and the molding material is being injected through the gate orifice. Due to their role in aligning valve tip 204 and gate orifice 208 with one another via participating in aligning nozzle stack 236, seal ring 240 and wall 252, and any relevant functional parts thereof, are referred to herein and in the appended claims as “nozzle stack alignment features.” Seal ring 240 can comprise any suitable material(s), such as a ceramic material or metal (e.g., titanium), that preferably, though not necessarily, has a relatively low thermal conductivity to inhibit heat transfer from nozzle tip 248 to gate insert 216. As those skilled in the art will readily appreciate, seal ring 240 can be made of all one material, or may be made of multiple materials. As an example of multiple materials, the materials can be arranged so that one or more of the materials provides a suitable thermal barrier to the flow of heat from nozzle tip 248 to gate insert 216.

As those skilled in the art will readily appreciate, in order to provide its sealing functionality, seal ring 240 is solid, nonporous, and continuous around nozzle tip 248. In this example, seal ring 240 is shrink

fitted to nozzle tip 248, but in other embodiments, the seal ring can be affixed to the nozzle tip using other means, such as a threaded connection, and being formed monolithically with the nozzle tip (e.g., using 3D printing technology), among others known in the art. As those skilled in the art will also readily appreciate, in some embodiments the seal ring can be simply a ridge, or other feature (including
5 a cylindrical surface) formed around the circumference of nozzle tip 248 and that is designed and configured to snugly engage wall 252 or feature protruding from the wall, such as an annular ridge formed on the wall and extending generally inward toward central axis 260 of gate insert 216.

In this example, cavity locator 244 is also fixedly secured to nozzle tip 248 and is configured to slidably engage a wall 264 of cavity 256 of gate insert 216 distally from gate orifice 208 as the nozzle
10 tip is inserted into the cavity. Cavity locator 244 and wall 264 are designed and configured to provide primary alignment interface 224. Due to their role in aligning valve tip 204 and gate orifice 208 with one another via participating in aligning nozzle stack 236, cavity locator 244 and wall 264, and any relevant functional parts thereof, are referred to herein and in the appended claims as “nozzle stack alignment features.” Cavity locator 244 can comprise any suitable material, such as metal (e.g.,
15 titanium), that preferably, though not necessarily, has a relatively low thermal conductivity to inhibit heat transfer from nozzle tip 248 to gate insert 216. As those skilled in the art will readily appreciate, cavity locator 244 can be made of all one material, or may be made of multiple materials. As an example of multiple materials, the materials can be arranged so that one or more of the materials provides a suitable thermal barrier to the flow of heat from nozzle tip 248 to gate insert 216.

In addition, or alternatively, to including one or more materials having relative low thermal conductivity, cavity locator 244 can be shaped in a manner that reduces the transverse cross-sectional area of the cavity locator to reduce the amount of material conducting heat from nozzle tip 248 to gate insert 216. For example, FIG. 3 illustrates cavity locator 244 as including openings 300 that
20 significantly reduce the area of the cavity locator available for conducting heat from nozzle tip 248 to gate insert 216. Those skilled in the art will readily appreciate that the configuration of openings 300 is simply an example and that any openings provided can be configured in any suitable manner. In addition, while openings 300 are apertures completely surrounded by material of cavity locator 244, other openings, such as notches around the periphery of the cavity locator, can be provided in the alternative or in addition to one or more fully encircled apertures. Referring again to FIG. 2, cavity
25 locator 244 can additionally, or alternatively, be made as thin as possible to minimize its thermal conductive area, while maintaining sufficient strength and stiffness to achieve the desired nozzle stack alignment functionality.

Referring still to FIG. 2 and also briefly to FIG. 3, in the example shown there, cavity locator 244 includes a thickened rim 244A that extends around the outer periphery of the cavity locator. Rim 244A

has a curved gate-insert-engaging surface 244B that can engage various parts of wall 264 of cavity 256 during insertion of nozzle tip 248 into the cavity so as to assist in aligning nozzle stack 236. In the embodiment shown, wall 264 of cavity 256 includes a shoulder 272 that defines a recess 276 that is designed and configured to snugly receive rim 244A of cavity locator 244 so that when the cavity

5 locator is snugly received therein (in conjunction with seal ring 240 being snugly engaged with wall 252 of cavity 256), nozzle stack 236 is properly oriented for correct alignment between valve tip 204 and gate orifice 208. In other words, recess 276 functions as a nozzle stack alignment feature on gate insert 216.

It is noted that, like conventional injection-molding apparatus 10 of FIG. 1, injection-molding

10 apparatus 200 of FIG. 2 includes a nozzle stack locator 280 that engages manifold plate 212. Indeed, nozzle stack locator 280 corresponds to nozzle locator 34 of FIG. 1 and is present in this example to provide a general alignment of nozzle stack 236 prior to nozzle tip 248 being inserted into cavity 256 of gate insert 216. So that nozzle stack locator 280 does not interfere with primary alignment

15 interfaces 220 and 224, the fit on the nozzle stack locator must be loosened relative to the fit that may be present in conventional devices. All of the parts of injection-molding apparatus 200 of FIG. 2 not explicitly described can be the same as or similar to the corresponding parts of injection-molding apparatus 10 of FIG. 1.

FIG. 4 illustrates a nozzle stack/gate arrangement 400 that includes first and second primary alignment interfaces 404 and 408 for properly aligning a valve tip 412 with a gate orifice 416. It is noted that in

20 this embodiment, valve tip 412 is shown in its closed position in which it is engaged within gate orifice 416, in contrast to positions of valve tips 56 and 204 of FIGS. 1 and 2, respectively. In this example, arrangement 400 includes a nozzle stack 420 (only part of which appears in FIG. 4) and a gate region 424A of a cavity plate 424. Gate region 424A is similar to gate insert 216 of FIG. 2, except the cavity 460 is not formed in a separate part that is installed into a cavity plate 424. Rather, cavity 460 is

25 formed directly in cavity plate 424 in gate region 424A. Those skilled in the art will readily appreciate that nozzle stack/gate arrangement 400 can be used with a gate-insert-type arrangement. Likewise, nozzle stack/gate insert arrangements, such as the arrangements shown in FIGS. 2 and 6, can be used in non-gate-insert-type arrangements.

Nozzle stack 420 has a different construction relative to nozzle stack 236 of FIG. 2. As seen in FIG. 4,

30 nozzle stack 420 includes a main body 428 and a nozzle tip 432 of an insertion type, i.e., it is engaged with the main body by insertion into a tip receptacle 436 formed in the main body. This nozzle-tip type is in contrast to the external type shown in FIGS. 1 and 2. Nozzle stack 420 of FIG. 4 also includes a thermal coupler 440 that holds a heating coil (not shown) in a helical channel 444.

In the embodiment of FIG. 4, first primary alignment interface 404 includes contacting surfaces 448 and 452 on main body 428 of nozzle stack 420 and on a wall 456 of cavity 460 in gate insert 424.

Second primary alignment interface 408 includes a cavity locator 464 that is fixedly engaged with main body 428 of nozzle stack 420 and that is snugly engaged with a surface 468 of cavity 460 in gate insert 424. In this example, surface 468 is part of a recess 472 that has been precisely formed to snugly, but slidably engage cavity locator 464 as nozzle tip 432 is inserted into cavity 460. Cavity locator 464 may be configured similar to cavity locator 244 of FIGS. 2 and 3 relative to thermal-conductance-inhibiting features, such as apertures, notches, thinning, use of low-thermal-conductance material(s), etc, and any logical combination of these. In the example shown, cavity locator 464 has a turned-down (relative to the orientation in FIG. 4) rim 476 that gives the cavity locator somewhat of a wide-mouth-jar-lid configuration. As those skilled in the art will readily appreciate, turned-down rim 476 can provide cavity locator 464 with a measure of spring action in a direction transverse to the longitudinal axis of nozzle stack 420. As with cavity locator 244 of FIGS. 2 and 3, cavity locator 464 can be made of any suitable material, such as metal.

FIG. 5 illustrates yet another nozzle stack/gate insert arrangement 500 that includes first and second primary alignment interfaces 504 and 508 for properly aligning a valve tip 512 with a gate orifice 516. In this example, arrangement 500 includes a nozzle stack 520 (only part of which appears in FIG. 5) and a gate insert 524. Nozzle stack 520 is generally like nozzle stack 236 of FIG. 2 in that it includes a nozzle tip 528 that is externally attached to a main body 532, as opposed to the insertion-type nozzle tip 432 of FIG. 4. Nozzle stack 520 of FIG. 5 also includes a thermal coupler 536 that holds a heating coil (not shown) in a helical channel 540. Gate insert 524 includes a cavity 544 for receiving a portion of nozzle stack 520.

In this example, first primary alignment interface 504 comprises a seal ring 548 that is fixedly engaged with nozzle tip 528 and, when in the location shown, is snugly and sealingly engaged with a surface 552 of gate insert 524 that partially defines cavity 544. Like seal ring 240 of FIG. 2, seal ring 548 can comprise any suitable material(s), such as a ceramic material or metal (e.g., titanium), that preferably, though not necessarily, has a relatively low thermal conductivity to inhibit heat transfer from nozzle tip 528 to gate insert 524. Similarly, seal ring 548 of FIG. 5 can have any alternative configuration that provides the requisite sealing and aligning functionalities, examples of which are presented above relative to seal ring 240 of FIG. 2.

Second primary alignment interface 508 in the embodiment shown in FIG. 5 includes a cavity locator ring 556 fixedly secured to gate insert 524, here, using threaded fasteners 560 engaged with corresponding respective threaded holes 564. Those skilled in the art will readily appreciate that while threaded fasteners 560 are shown, cavity locator ring 556 can be secured to gate insert 524 in any

suitable manner, such as by other threaded fastening mean and non-threaded fastening means, such as welding, among others. In some embodiments, cavity locator ring 556 can be formed monolithically with gate insert 524. Cavity locator ring 556 can be made of any one or more suitable materials, including materials having low thermal conductivity, such as, for example, titanium and ceramic materials.

Second primary alignment interface 508 also includes a nozzle spacer 568 secured to nozzle tip 528 and designed and configured to snugly engage the inner periphery 556A of cavity locator ring 556. Nozzle spacer 568 can be secured to nozzle tip 528 in any suitable manner, such as by shrink fit, welding, etc. In some embodiments, nozzle spacer 568 can be formed monolithically with nozzle tip 528. Regardless of the form of nozzle spacer 568, and cavity locator ring 556 for that matter, care is taken to ensure that these two structures engage one another with the snugness necessary to properly align valve tip 512 with gate orifice 516 when nozzle tip 528 is fully engaged within cavity 544. As seen best in FIG. 6, nozzle spacer 568 can be provided with features, here notches 600, that reduce the area of the nozzle spacer available for conducting heat from nozzle tip 528 to gate insert 524. In addition, or alternatively, to notches, such as notches 600 (FIG. 6), nozzle spacer 568 can be provided with openings, for example, in a manner similar to openings 300 of cavity locator 244 as shown in FIG. 3. It is noted that any notches and/or openings provided can be used to run any wires or conduits, such as heater and thermocouple wires (not shown). Nozzle spacer 568 can also, or alternatively, be made of a suitable relatively low thermally conductive material, such as titanium or a ceramic material, among others. With nozzle spacer 568 secured to nozzle stack 520, it can be considered to be part of the nozzle stack. Likewise, with cavity locator ring 556 secured to gate insert 524, it can be considered part of the gate insert.

Exemplary embodiments have been disclosed above and illustrated in the accompanying drawings. It will be understood by those skilled in the art that various changes, omissions and additions may be made to that which is specifically disclosed herein without departing from the spirit and scope of the present invention.

WHAT IS CLAIMED IS:

1. An injection-molding apparatus, comprising:
a gate region that includes:
a first longitudinal axis;
a gate orifice;
a first nozzle stack alignment feature; and
a second nozzle stack alignment feature spaced from said first nozzle stack alignment feature along said first longitudinal axis; and
a nozzle stack that includes:
a second longitudinal axis located so as to be parallel to said first longitudinal axis of said gate region during engagement of said nozzle stack with said gate region when the injection-molding apparatus is operating;
a valve member movable along said second longitudinal axis so as to be intermittently engaged with said gate orifice when the injection-molding apparatus is operating;
a third nozzle stack alignment feature designed and configured to engage said first nozzle stack alignment feature; and
a fourth nozzle stack alignment feature designed and configured to engage said second nozzle stack alignment feature.
2. The injection-molding apparatus according to claim 1, wherein said gate region includes a nozzle cavity having a first end and a second end spaced from said first end along said first longitudinal axis, said gate orifice located at said first end, said first nozzle stack alignment feature located proximate to said first end, and said second nozzle stack alignment feature located proximate to said second end.
3. The injection-molding apparatus according to claim 2, wherein said second nozzle stack alignment feature comprises an alignment insert secured to said gate region.
4. The injection-molding apparatus according to claim 3, wherein said alignment insert includes an annular central portion and a plurality of circumferentially spaced tabs extending radially from said annular central portion.
5. The injection-molding apparatus according to claim 3, wherein said fourth nozzle stack alignment feature comprises an outer surface of said nozzle stack.
6. The injection-molding apparatus according to claim 3, wherein said first nozzle stack alignment feature comprises a wall of said cavity.

7. The injection-molding apparatus according to claim 6, wherein said third nozzle stack alignment feature comprises an alignment ring.
8. The injection-molding apparatus according to claim 6, wherein said nozzle stack includes a nozzle tip and a nozzle heater and said cavity has a first region designed and configured to receive said nozzle tip, and a second region designed and configured to receive said nozzle heater, said wall defining at least a portion of said first region.
9. The injection-molding apparatus according to claim 2, wherein said fourth nozzle stack alignment feature comprises an alignment device secured to said nozzle stack and having at least one cavity-engaging locating member designed and configured to slidably engage said second alignment feature of said gate region.
10. The injection-molding apparatus according to claim 9, wherein said second nozzle stack alignment feature comprises a wall of said cavity.
11. The injection-molding apparatus according to claim 1, further comprising a cavity plate and a gate insert engaged with said cavity plate, wherein said gate insert defines said gate region.
12. The injection-molding apparatus according to claim 1, further comprising a cavity plate, said cavity plate defining said gate region.
13. A nozzle stack for use in injection-molding apparatus that includes a gate region having a first longitudinal axis and including a nozzle-receiving cavity extending along the first longitudinal axis and a gate orifice located along the first longitudinal axis and in fluid communication with said nozzle receiving cavity, the gate region having a first alignment feature located in the nozzle-receiving cavity proximate to the gate orifice and a second alignment feature located in the nozzle-receiving cavity distal from the gate orifice, the nozzle stack comprising:
 - a second longitudinal axis located so as to be parallel to the first longitudinal axis of the gate region during engagement of the nozzle stack with said gate region;
 - a valve member movable along said second longitudinal axis so as to be intermittently engaged with the gate orifice when the injection-molding apparatus is operating;
 - a third alignment feature designed and configured to engage the first alignment feature; and
 - a fourth alignment feature designed and configured to engage the second alignment feature;wherein engagement of said third alignment feature with the first alignment feature and said fourth alignment feature with the second alignment feature cooperate to align said valve member with the gate orifice.

14. The nozzle stack according to claim 13, wherein said fourth alignment feature comprises a surface of the nozzle stack that is designed and configured to snugly engage the second alignment feature of the gate region.
15. The nozzle stack according to claim 14, wherein said nozzle stack includes a nozzle tip and said third alignment feature comprises an alignment device secured to said nozzle tip.
16. The nozzle stack according to claim 13, wherein said fourth alignment feature comprises an alignment device secured to the nozzle stack and having at least one cavity-engaging locating member designed and configured to slidably engage the second alignment feature of the gate region.
17. The nozzle stack according to claim 14, wherein said nozzle stack includes a nozzle tip and said third alignment feature comprises an alignment device secured to said nozzle tip.
18. A gate structure for use in an injection molding apparatus that includes a nozzle stack having a second longitudinal axis and including a valve member movable along the second longitudinal axis, a third alignment feature, and a fourth alignment feature, the gate structure comprising:
 - a first longitudinal axis located so as to be parallel to the second longitudinal axis of the nozzle stack during engagement of the nozzle stack with said gate structure when the injection-molding apparatus is operating;
 - a nozzle-receiving cavity extending along said first longitudinal axis;
 - a gate orifice located along said first longitudinal axis and in fluid communication with said nozzle-receiving cavity;
 - a first alignment feature located proximate to said gate orifice and designed and configured to engage the first alignment feature; and
 - a second alignment feature spaced from said first nozzle stack alignment feature along said first longitudinal axis and designed and configured to engage the second alignment feature;wherein engagement of the third alignment feature with said first alignment feature and the fourth alignment feature with said second alignment feature cooperate to align the valve member of the nozzle stack with said gate orifice.
19. The gate structure according to claim 18, wherein the gate structure comprises a body containing said cavity and said second alignment feature comprises an alignment insert secured to said body.
20. The gate structure according to claim 19, wherein said body comprises a gate insert.

21. The gate structure according to claim 19, wherein said body comprises a cavity plate.
22. The gate structure according to claim 19, wherein the nozzle stack includes a nozzle tip and an alignment ring engaged with the nozzle tip, and said cavity includes a narrow portion designed and configured to snugly receive the alignment ring.
23. The gate structure according to claim 18, wherein the fourth alignment feature comprises an alignment device extending laterally from the nozzle stack, said second alignment feature comprising a portion of a wall of said cavity.
24. The gate structure according to claim 19, wherein the nozzle stack includes a nozzle tip and an alignment ring engaged with the nozzle tip, and said cavity includes a narrow portion designed and configured to snugly receive the alignment ring.

1 / 4

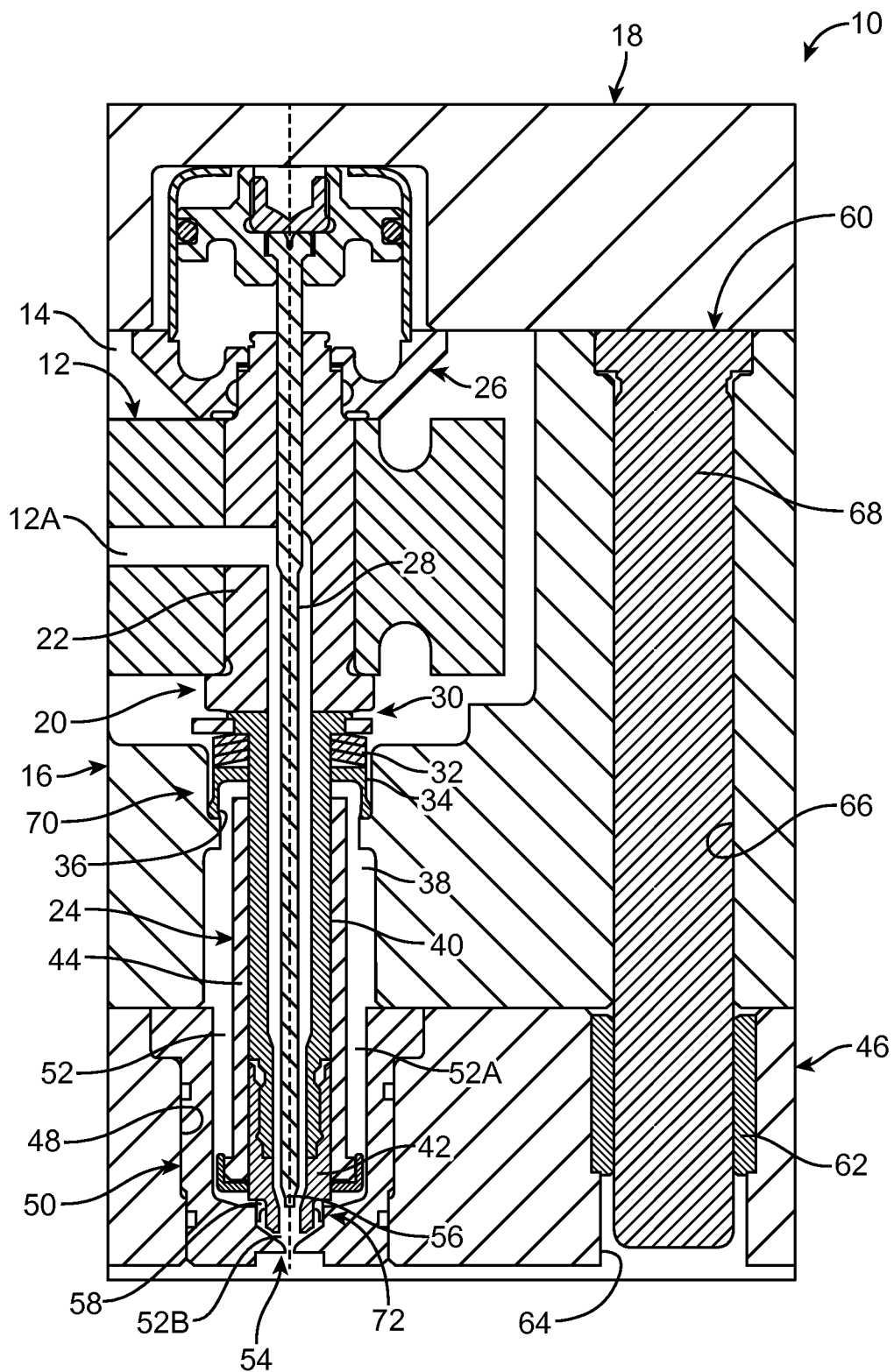


FIG. 1
(PRIOR ART)

2 / 4

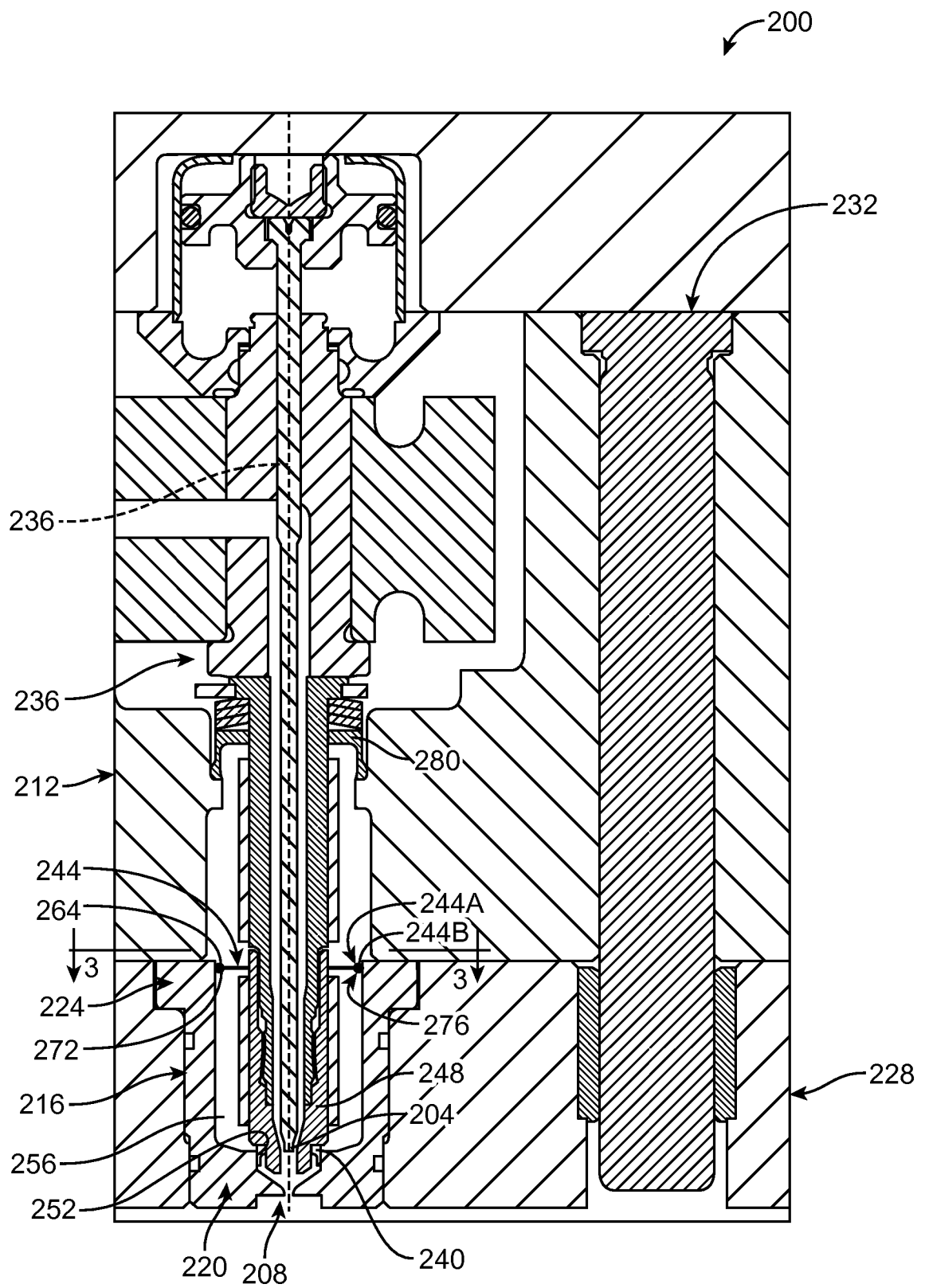


FIG. 2

3 / 4

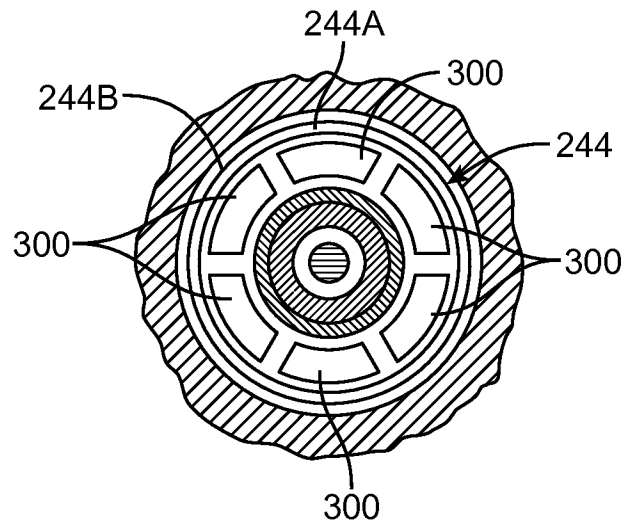


FIG. 3

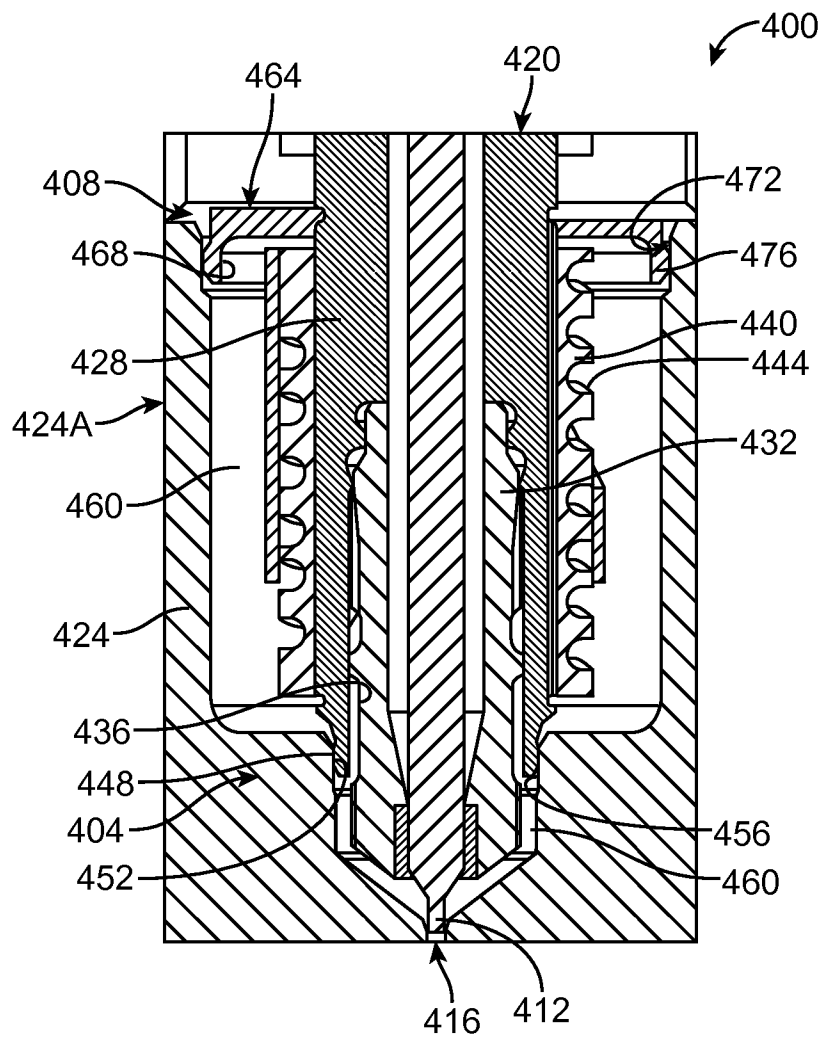


FIG. 4

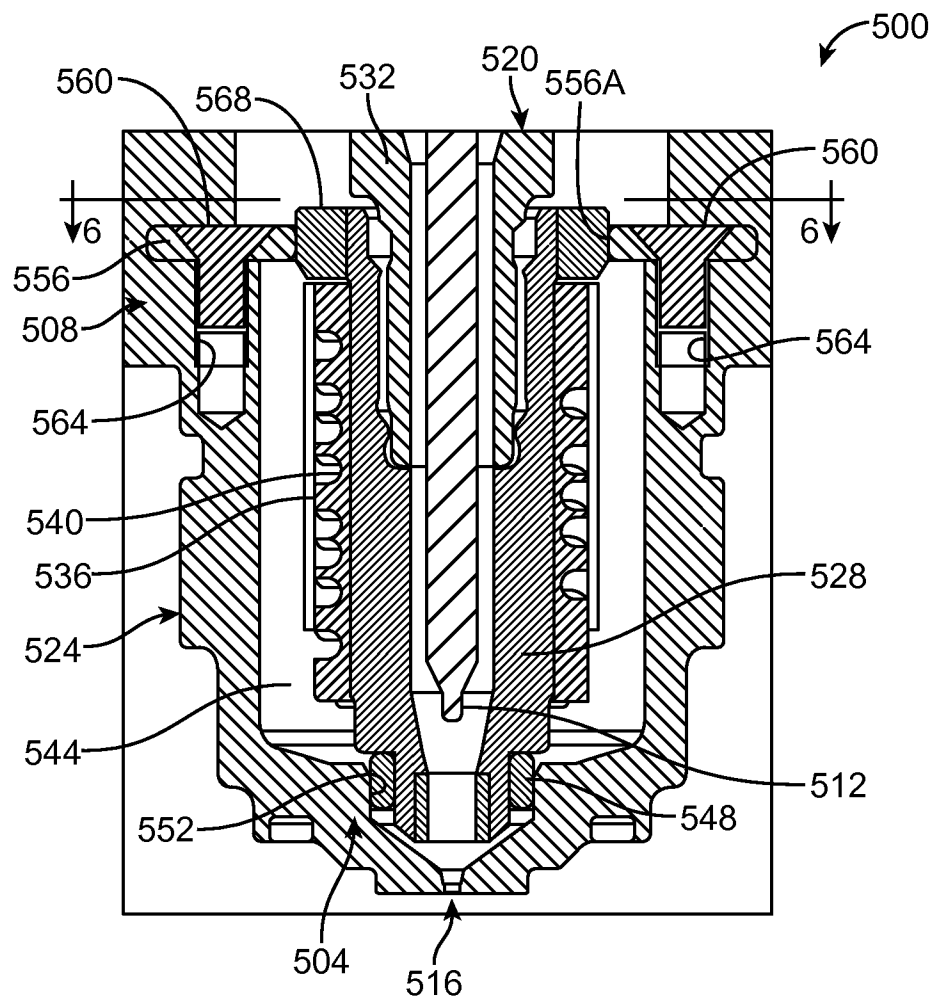


FIG. 5

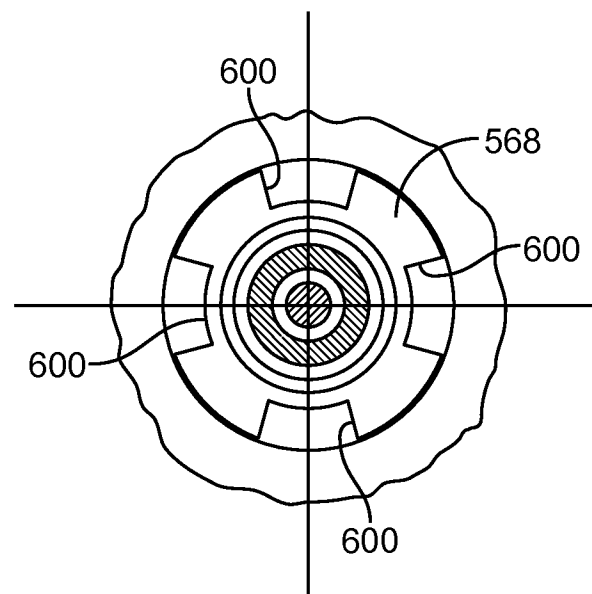


FIG. 6