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(54) **METHOD AND APPARATUS FOR INJECTION MOLDING ARTICLES**

(75) Inventor: **Joachim Johannes Niewels**, Thornton (CA)

Correspondence Address:
HUSKY INJECTION MOLDING SYSTEMS, INC
288 NORTH ROAD
MILTON, VT 05468 (US)

(73) Assignee: **Husky Injection Molding, Ltd.**, 500 Queen Street South, Bolton (CA)

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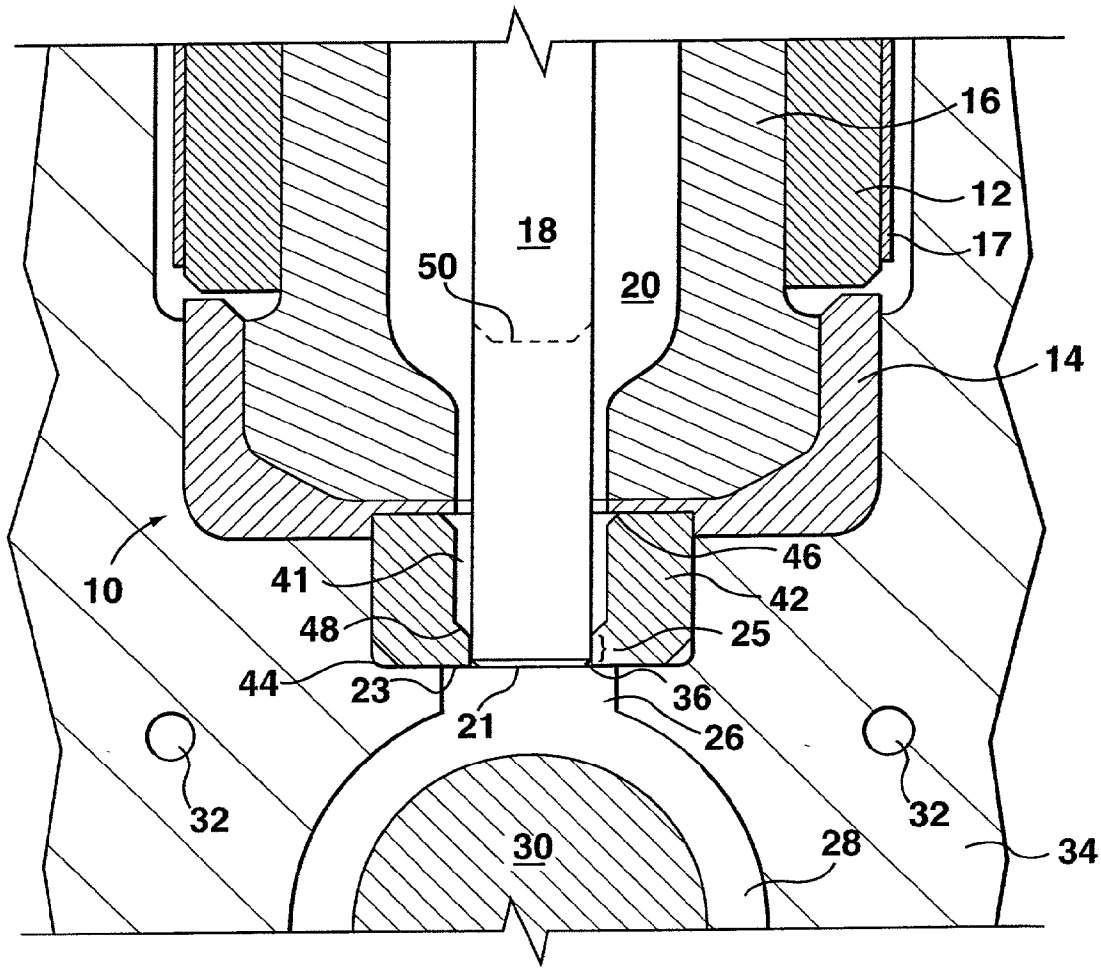
(57) **ABSTRACT**

An injection molding system having an improved valve gate arrangement that provides molded articles with improved vestige and or surface quality.



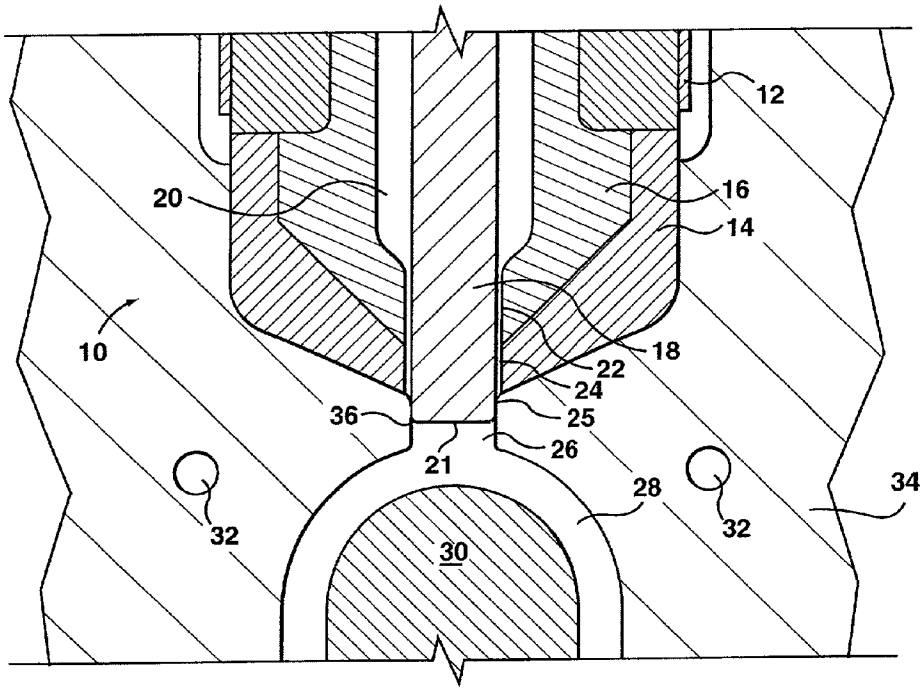


FIG. 1 (PRIOR ART)

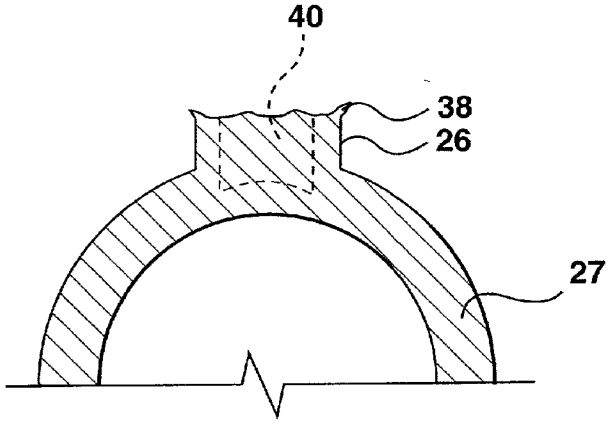


FIG. 2 (PRIOR ART)

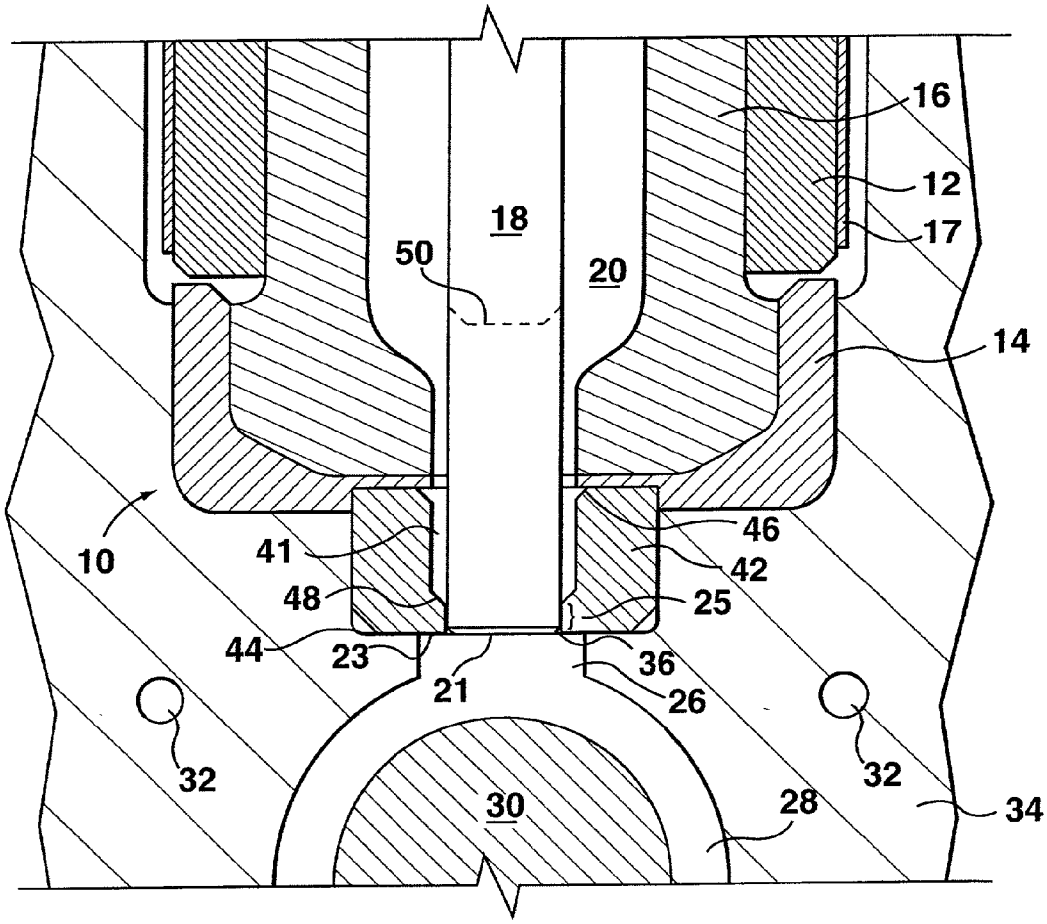


FIG. 3

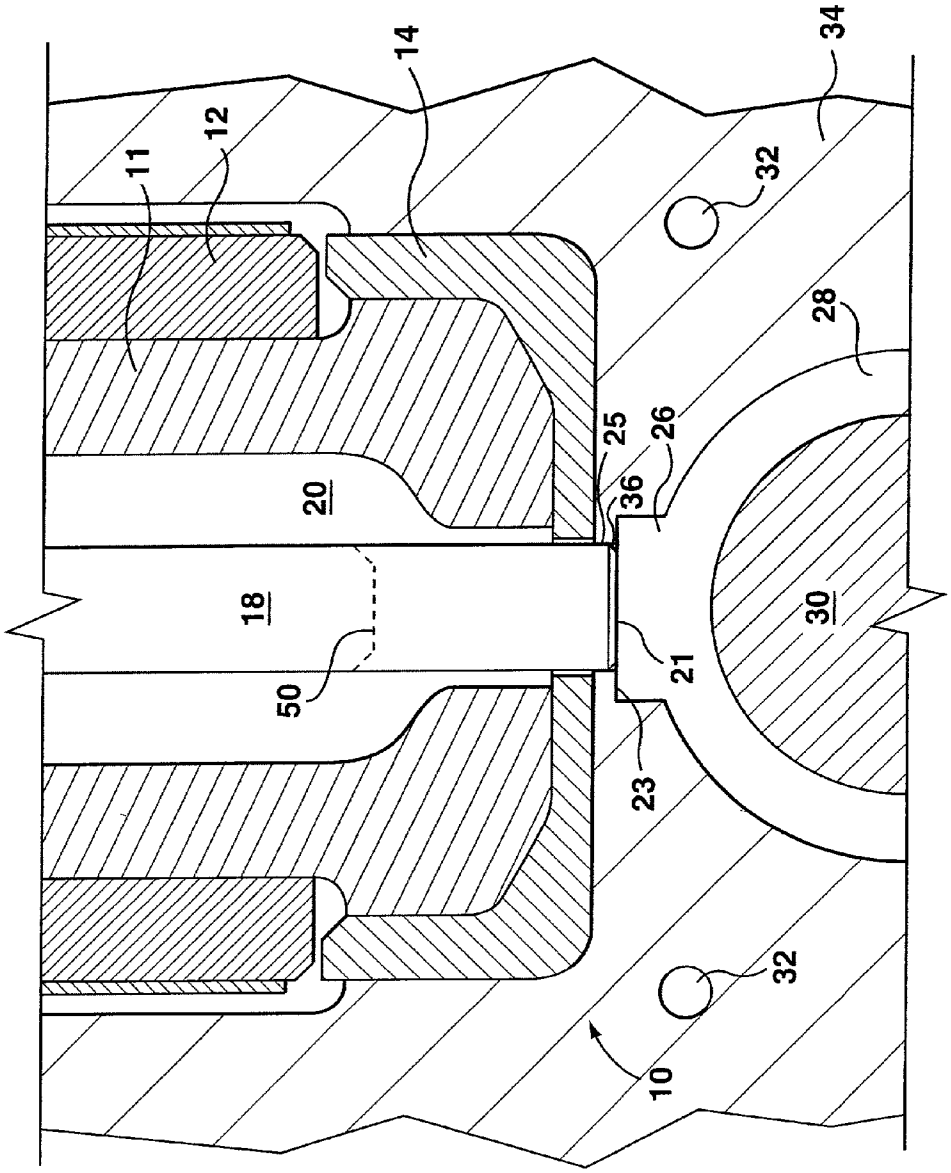


FIG. 3a

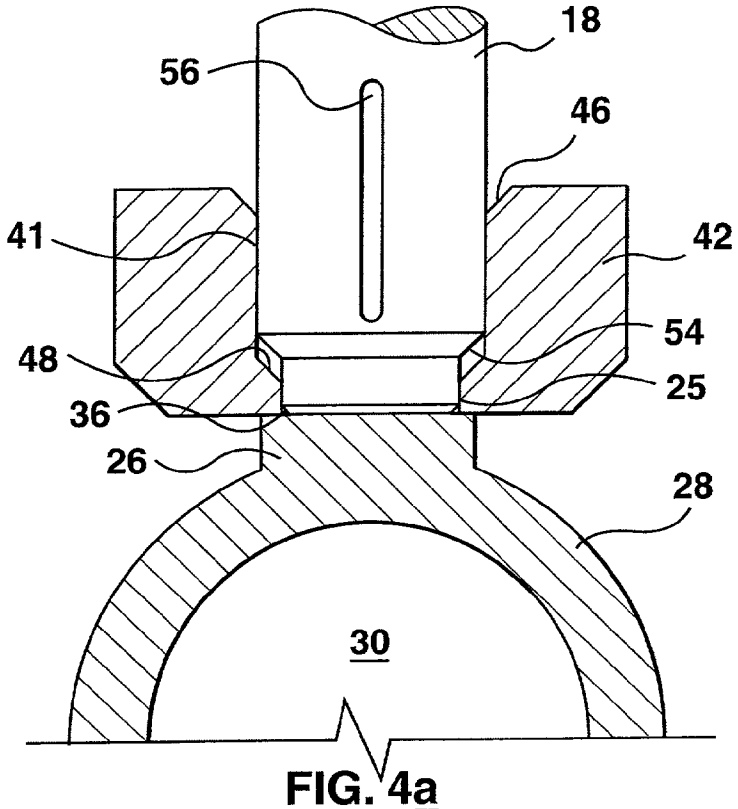


FIG. 4a

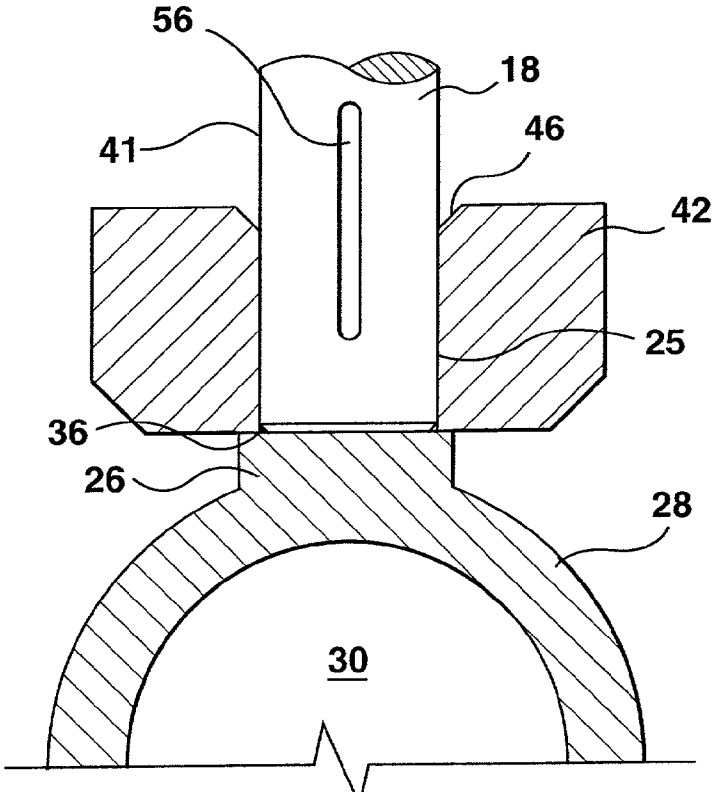


FIG. 4b

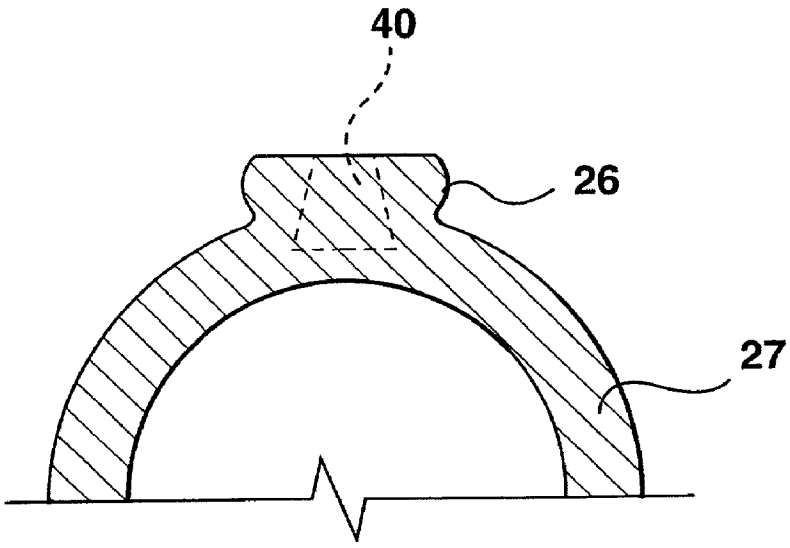


FIG. 5

METHOD AND APPARATUS FOR INJECTION MOLDING ARTICLES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to injection molding systems. More specifically, the present invention relates to a valve gating system found in injection molding systems.

[0003] 2. Summary of the Prior Art

[0004] Injection molding nozzles are well known and are used to inject materials, such as plastic, into the cavity of a mold. For example, such nozzles receive molten material, such as plastic, from an injection molding machine and direct the same into a mold cavity through a passage called a gate. When an injection operation is complete, and prior to opening the mold cavity to eject the molded part, the transfer of molten material through the gate must be stopped. Generally, two methods exist for stopping the transfer of molten material through the gate, namely: thermal, or open, gating; and valve gating.

[0005] In thermal gating, the gate is an open aperture through which molten material passes during an injection operation. The gate is rapidly cooled at the end of the injection portion of the cycle, when the injection pressure is removed, to "freeze" the injected material into a plug. This plug remains in the gate to prevent drool of molten material from the gate when the mold is open for the ejection of the molded part. In the next injection portion of the cycle, the cooling applied to the gate is removed and hot molten material from the injection molding machine pushes the plug into the mold cavity, where it melts and mixes with the newly provided molten material.

[0006] In valve gating, the opening and closing of the gate is independent of injection pressure and/or cooling and is achieved mechanically with a valve stem. This stem can be moved between an open position, wherein flow of molten materials through the gate is permitted, and a closed position wherein the gate is closed by entry of the valve stem into the gate which establishes a seal, preventing molten materials from passing through the gate. Valve gating is well known and examples of such systems are shown in U.S. Pat. Nos. 2,878,515; 3,023,458; and 3,530,539, each being incorporated herein by reference.

[0007] Generally, for situations that require improved aesthetics, valve gating is preferable to thermal gating because it can reduce the undesired gate vestige which results on the finished molded part. However, there are problems with valve gating systems.

[0008] Specifically, the valve stem and gate each have a complementary sealing portion which are brought into contact to seal the gate. Typically there is a 0.001"-0.002" diametrical clearance between the valve stem and the gate sealing portion. As the valve stem is moved into alignment with the sealing portion of the gate to effect sealing, a slight misalignment of the stem with the gate will cause the stem to strike the gate sealing portion. Over time, this will cause the gate area to wear and become misshapen. Now that the gate sealing area is worn, the stem no longer stops the flow of molten material and a small amount of molten material will migrate between the stem and the worn gate sealing area. This leakage adversely impacts the vestige quality because as the mold is opened, the now solidified material between the gate and the valve stem will cause a tear or blemish to form along the vestige of the part, and in extreme cases, the tearing can propagate to the surface of the molded article or preform.

[0009] Following the injection cycle, typically the mold halves will open and the molded article in a somewhat solidified state will be removed from the area of the stem/gate area. Due to the entrapped molten material between the worn gate area and the stem, the molded article will not break away cleanly when the mold is opened, but rather will tear away from the gate area, which results in a blemished vestige on the molded article.

[0010] Referring to **FIGS. 1 and 2** this phenomenon can be clearly seen. As well known in the art, a nozzle assembly **10** is comprised of an elongated nozzle bushing **12** with a nozzle tip **16** affixed co-axially therein. Optionally, an insulator **14** is affixed to a proximal end of the nozzle tip **16** thereby thermally insulating the heated nozzle assembly **10** from the cooled cavity plate **34**. A movable valve member **18** extends co-axially in the nozzle assembly **10** and is selectably positioned in or out of a passageway/gate area **22**. A melt channel **20** surrounds the valve member **18** and runs the length of the nozzle assembly **10** to communicate a flowable material to a mold cavity **28**. When the valve member **18** is placed in a fully closed position (as shown in **FIG. 1**), a sealing portion **25** in the cavity plate **34** sealingly surrounds the valve member **18** to shut off the flow of material to the mold cavity **28**. As shown in **FIG. 1, a** face portion **21** of valve member **18** defines the entire top of the vestige **26** of the molded article. A chamfer **36** is typically provided along the face of the valve member **18** to help guide the valve member into the gate area and reduce wear of the valve member and cavity plate **34**.

[0011] Due to the close fit of the valve member **18** to the sealing portion **25**, any misalignment that exists between their respective interfaces will cause the valve member **18** to strike the surface of the sealing portion **25** which will ultimately lead to a deterioration of the seal portion **25** and/or the valve member **18**.

[0012] At the end of the injection cycle, the valve member **18** is moved into its closed position as previously described and the mold cavity is held in a closed position with a core **30** for a predetermined cycle time to allow the molten material to cool and solidify, thereby forming the molded article. Once the molded article has been allowed to cool to a sufficient level, the core **30** with the molded article thereon is moved in the direction as denoted by arrow A, and the vestige **26** is pulled away from the face portion **21** of the valve member **18**. If enough wear exists between the valve member **18** and the sealing portion **25**, a small amount of molten material will migrate therein, and as the mold core **30** and the molded article **27** are moved to an open position, a peeled edge **38** will form on the vestige **26** of the molded article **27**.

[0013] Also, as the valve member **18** is in the flow of molten material when the gate is open, it can become quite hot. When the gate is closed by the valve member **18**, the hot tip of the valve member **18** can be difficult to cool as the mold cavity **28** is cooled and this can result in a need for increased cycle times to permit the necessary cooling, and/or

can result in undesirable characteristics in the molded article **27**. Specifically, as the material in the mold cavity **28** adjacent the valve member **18** is cooled less efficiently due to the hot tip, parts molded from thermally sensitive materials such as PET can suffer from an enlarged area of crystallinity **40** or other undesired characteristics. In addition, since the entire top surface of the vestige **26** is in contact with the face portion **21** of the hot valve member **18**, the molten material adjacent the face portion **21** remains somewhat molten and stringing and an uneven edge forms when the mold is opened.

[**0014**] Therefore there is a need for an improved injection-molding machine with a valve gate system that reduces or obviates some or all of the drawbacks of the prior art.

SUMMARY OF THE INVENTION

[**0015**] The primary objective of the present invention is to provide an improved injection molding system with a valve gating system that reduces or obviates the drawbacks of the prior art.

[**0016**] Another object of the present invention is to provide an insert that interfaces with a valve member in an injection molding system that reduces or eliminates the formation of peeled edges along a vestige of a molded article.

[**0017**] Yet another object of the present invention is to provide a gate insert in the mold plate adjacent the valve member that may be easily replaced.

[**0018**] The foregoing objects are achieved by providing a mold cavity with a vestige cross-sectional area that is larger than the cross-sectional area of the valve member so that the periphery of the vestige is cooled quicker than the interior portion of the vestige. In another preferred embodiment, a replaceable insert is provided to help guide the valve member into a sealing position with the gate. Replacement of this insert can easily be performed whenever the wear of the insert reaches a predetermined and unacceptable level.

[**0019**] Further objections and advantages of the present invention will appear hereinbelow.

BREIF DESCRIPTION OF THE DRAWINGS

[**0020**] **FIG. 1** is a simplified cross-sectional view of an injection molding nozzle in accordance with the prior art;

[**0021**] **FIG. 2** is a partial cross-sectional view of a molded article in accordance with the prior art;

[**0022**] **FIGS. 3 and 3***a* are simplified cross-sectional views of exemplicative embodiments in accordance with the present invention;

[**0023**] **FIGS. 4***a* and **4***b* are partial cross-sectional views of alternate exemplicative embodiments in accordance with the present invention;

[**0024**] **FIG. 5** is a simplified partial cross-sectional view of a molded article.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[**0025**] Referring now to **FIG. 3**, an injection molding nozzle assembly **10** in accordance with the present invention is located in a cavity plate **34** for the communication of a flowable material to a mold cavity **28** for the formation of a molded article therein. Cavity plate **34** is provided with a plurality of cooling passageways **32** therein for the communication of a cooling fluid for the removal of heat from the cavity plate to cool and solidify the flowable material in the mold cavity **28**.

[**0026**] The nozzle assembly **10**, as well known in the art, is comprised of an elongated nozzle bushing **12** with a nozzle tip **16** affixed to a proximal end of the nozzle bushing. In a preferred embodiment, the nozzle tip **16** is threaded to the nozzle bushing **12**, but any such suitable means could be used. Typically, a heater **17** is wrapped around the nozzle assembly **10** to maintain the flowable material in a viscous state. In the preferred embodiment an optional insulator **14** is located between the nozzle tip **16** and the cooled cavity plate **34** to reduce the transfer of heat from the hot nozzle tip **16** to the cooled cavity plate **34**. Located co-axially in the nozzle assembly **10** is a movable valve member **18** that extends adjacent a vestige **26** of the mold cavity **28**. In a preferred embodiment, the valve member **18** is a slender elongated cylindrical piece that is moved up and down to an open and closed position respectively. When the valve member **18** is in the open position as shown by phantom line **50**, the flowable material in melt channel **20** is allowed to enter the mold cavity **28**. When placed in the closed position, as shown in **FIG. 1**, the valve member **18** is in sealing communication with a sealing portion **25** thereby stopping the flow of material to the mold cavity **28**.

[**0027**] In one preferred embodiment, an insert **42** with a passageway **41** formed therein is placed in a cavity **44** located in the cavity plate **34** in alignment with the valve member **18**. In this arrangement, the sealing portion **25** is located in this replaceable insert **42** to allow for easy maintenance when leakage around the valve member **18** starts to occur.

[**0028**] The insert **42** may optionally provide a first chamfer **46** to help guide the valve member **18** when it first enters the passageway **41** and a second chamfer **48** to help guide the valve member further into the sealing portion **25**. These chamfers act to reduce wear on both the valve member **18** and the insert **42** and prolong the useable life of both components.

[**0029**] Vestige **26**, as shown in the figures, has a cross-sectional area larger than the face portion **21** of the valve member **18**. As such, a portion **23** of the vestige **26** is in thermal communication with the insert **42**. Given that the insert **42** is placed in the cooled cavity plate **34**, the insert **42** will cool portion **23** faster than the portion in contact with face portion **21** of the hot valve member **18**. This differential cooling action will allow portion **23** to solidify before the area adjacent face portion **21**. When core **30** is retracted to remove the molded article from the mold cavity **28**, this now solidified portion **23** will tend to breakaway more cleanly than the prior art. In addition, due to the location of the sealing portion **25** being internal and displaced from the outer surface of the finished vestige **26**, any tearing that may occur when the mold is opened is reduced or eliminated because the tear is not on the surface of the vestige/preform as in the prior art.

[**0030**] As shown in **FIG. 5**, this clean break will result in a more uniform and flat vestige **26** than previously seen. In

addition, a reduced area of crystallinity **40** will form inside the molded article **27** due to the improved cooling of the vestige **26**.

[**0031**] Referring to **FIG. 3**A, an alternative embodiment in accordance with the present invention is shown which is identical to the embodiment in **FIG. 3** except for the removal of the insert **42**. As shown in **FIG. 3**A, the sealing portion **25** is now located in the cavity plate **34**. Cooling of portion **23** will still occur quicker than in the remainder of the vestige **26**, which will allow for a substantially clean break when mold core **30** is retracted.

[**0032**] **FIGS. 4***a* and **4***b* (where like features have like numerals) show alternative embodiments of the insert **42** and the valve member **18**. As shown in **FIG. 4***a*, the valve member **18** has a chamfer **54** near the vestige **26**. A reduced diameter section of the valve member is in sealing communication with the sealing portion **25** when in the closed position. At least one elongated recess **56** is formed in the surface of the valve member **18** which allows the flowable material to be forced up along the valve member **18** as the valve member is brought to the closed position. Chamfers **46** and **48** help guide the valve member **18** as it enters the passageway **41** and seats in the sealing portion **25**. **FIG. 4***b* shows the valve member **18** as one continuous cylinder down to the chamfer at the very bottom. The passageway **41** in the insert **42** is also a uniform diameter for most of its length, except for the lead in chamfer **46**. In this embodiment, the sealing portion **25** can be longer and provide a longer lasting seal. The recess **56** allows the flowable material to flow up out of passageway **41** as the valve member **18** is brought to a closed position.

[**0033**] It is to be understood that the invention is not limited to the illustrations described herein, which are deemed to illustrate the best modes of carrying out the invention, and which are susceptible to modification of form, size, arrangement of parts and details of operation. The invention is intended to encompass all such modifications, which are within its spirit and scope as defined by the claims.

What is claimed is:

1. An apparatus for injection molding at least one article, said apparatus having at least one mold cavity and a supply of flowable material communicated to said mold cavity through at least one injection nozzle, comprising:

a movable valve member having a predetermined cross-sectional area to selectably start and stop the communication of said flowable material through a nozzle gate in each said nozzle, and;

a vestige adjacent said nozzle gate protruding from a surface of said article, wherein said vestige has a cross-sectional area greater than said cross-sectional area of said valve member.

2. The apparatus in accordance with claim 1 wherein said article is a preform.

3. The apparatus in accordance with claim 2 wherein said preform is made from PET.

4. The apparatus in accordance with claim 1 wherein said mold cavity is formed between a cavity plate and a mold core.

5. The apparatus in accordance with claim 4 wherein said mold core is selectably movable to an open and closed position.

6. The apparatus in accordance with claim 4 wherein said nozzle gate is located in said cavity plate.

7. The apparatus in accordance with claim 4 wherein said nozzle gate is located in an insert located in said cavity plate.

8. The apparatus in accordance with claim 7 wherein said insert is replaceable.

9. The apparatus in accordance with claim 1 wherein said injection nozzle comprises:

an elongated nozzle bushing having a melt passageway therein, said nozzle bushing placed in a cavity of a cavity plate in alignment with said mold cavity,

a nozzle tip affixed to said nozzle bushing for the communication of a flowable material from said nozzle bushing to said mold cavity,

a heater in thermal communication with said injection nozzle.

10. The apparatus in accordance with claim 1 wherein said valve member is cylindrical.

11. The apparatus in accordance with claim 1 wherein said valve member has a reduced diameter portion in sealing communication with said nozzle gate.

12. The apparatus in accordance with claim 1 wherein said valve member has at least one longitudinal recess on the surface of said valve member to allow for the communication of said flowable material.

13. An apparatus for injection molding at least one article comprising:

a source of flowable material in fluid communication with at least one injection nozzle, said injection nozzle having an outlet in alignment with a mold cavity for the formation of said article therein;

a movable valve member for selectably starting and stopping the communication of said flowable material through said outlet;

said article having a vestige adjacent said valve member, wherein the cross-sectional area of said valve member is less than said vestige.

14. The apparatus in accordance with claim 13 wherein said article is a preform.

15. The apparatus in accordance with claim 14 wherein said preform is made from PET.

16. The apparatus in accordance with claim 13 wherein said mold cavity is formed between a cavity plate and a mold core.

17. The apparatus in accordance with claim 16 wherein said mold core is selectably movable to an open and closed position.

18. The apparatus in accordance with claim 16 wherein said nozzle gate is located in said cavity plate.

19. The apparatus in accordance with claim 16 wherein said nozzle gate is located in an insert located in said cavity plate.

20. The apparatus in accordance with claim 19 wherein said insert is replaceable.

21. The apparatus in accordance with claim 13 wherein said injection nozzle comprises:

an elongated nozzle bushing having a melt passageway therein, said nozzle bushing placed in a cavity of a cavity plate in alignment with said mold cavity,

a nozzle tip affixed to said nozzle bushing for the communication of a flowable material from said nozzle bushing to said mold cavity,

a heater in thermal communication with said injection nozzle.

22. The apparatus in accordance with claim 13 wherein said valve member is cylindrical.

23. The apparatus in accordance with claim 13 wherein said valve member has a reduced diameter portion in sealing communication with said nozzle gate.

24. The apparatus in accordance with claim 13 wherein said valve member has at least one longitudinal recess on the surface of said valve member.

25. In an injection molding system, a manifold subsystem for the communication of a flowable material, comprising:

a manifold structure having at least one melt passageway in fluid communication with at least one injection nozzle;

a cavity plate in spaced-apart alignment with a mold core for the formation of a cavity therebetween, said nozzle being in fluid communication with said cavity through a nozzle gate for the formation of a molded article therein,

an insert having a passageway therethrough in fluid communication between said nozzle and said nozzle gate,

a movable valve member for selectably stopping and starting the communication of said flowable material to said cavity, and

said nozzle gate adjacent a vestige protruding from said molded article, wherein said vestige cross-sectional area adjacent said valve member is larger than the cross-sectional area of said valve member that contacts said molded article.

26. The apparatus in accordance with claim 25 wherein said molded article is a preform.

27. The apparatus in accordance with claim 26 wherein said preform is made from PET.

28. The apparatus in accordance with claim 25 wherein said mold core is selectably movable to an open and closed position.

29. The apparatus in accordance with claim 25 wherein said nozzle gate is located in said cavity plate.

30. The apparatus in accordance with claim 25 wherein said nozzle gate is located in an insert located in said cavity plate.

31. The apparatus in accordance with claim 30 wherein said insert is replaceable.

32. The apparatus in accordance with claim 25 wherein said injection nozzle comprises:

an elongated nozzle bushing having a melt passageway therein, said nozzle bushing placed in a cavity of a cavity plate in alignment with said mold cavity,

a nozzle tip affixed to said nozzle bushing for the communication of said flowable material from said nozzle bushing to said mold cavity,

a heater in thermal communication with said injection nozzle.

33. The apparatus in accordance with claim 25 wherein said valve member is cylindrical.

34. The apparatus in accordance with claim 25 wherein said valve member has a reduced diameter portion in sealing communication with said nozzle gate.

35. The apparatus in accordance with claim 25 wherein said valve member has at least one longitudinal recess on the surface of said valve member to allow for the communication of said flowable material.

36. In an injection molding system for the formation of a molded article, a gate insert comprising:

a body having a passageway formed therein, said passageway located between an injection nozzle assembly and a mold cavity for the communication of a fluid to said mold cavity,

an orifice portion of said passageway in sealing communication with a movable valve member such that when said valve member is adjacent said orifice portion the flow of said fluid to said cavity is prevented,

a raised portion protruding from said molded article in thermal communication with said gate insert and said valve member thereby cooling the outer periphery of said raised portion faster than the interior of said raised portion.

* * * * *