

METHOD AND APPARATUS FOR INJECTION MOLDING

FIELD OF THE INVENTION

The present invention is related to injection molding. In particular, the
5 present invention is related to the method and apparatus for the manufacture
of a molded part having a internal non-molded part.

BACKGROUND OF THE INVENTION

Injection molding is a conventional method for producing molded parts
shaped according to the mold. Since the injected material such as a polymer
10 resin is injected into the cavity of the mold, it is difficult to obtain the molded
part with a non-molded component enclosed therein. This problem is
compounded if a strict requirement is imposed on the exact positioning of the
non-molded part, e.g., if the non-molded part is required to be precisely at
the center or partially exposed at the edge of the molded part. Not only does
15 the non-molded part have to be introduced into the mold, but the position of
the non-molded part must also be maintained while the entire injection
molding process occurs. Traditional methods of introducing a secondary part
into a molded part, such as thermal bonding, mechanical fastening, adhesive
bonding and solvent cementing require a secondary process after the
20 molding process is complete. These methods do not allow embedding of a
secondary non-molded part within the molded part during the injection
molding process.

In a simple manual process, the non-molded part may be manually
placed into the mold before the mold is closed and the injection molding

performed. However, if precise alignment is required, even minor vibrations due to the movement of the mold and the injection of the resin may displace the non-molded part, particularly if the non-molded part is round and of very light weight, e.g. a very small metallic ball. As a result, the process is
5 inefficient and high rejection rates result.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide a mold injection system with improved efficiency to produce molded parts containing
10 a non-molded component therein.

It is another object of the present invention to provide an automated mold injection system to produce molded parts containing a non-molded component therein.

SUMMARY OF THE INVENTION

The present invention provides an injection molding apparatus and process which can maintain a non-molded part precisely within the mold cavity while the injection molding process occurs. The molded part produced using this
5 apparatus and process contains embedded non-molded parts at precise positions. The non-molded part may be, for example, a small metal ball which is required to be positioned partially exposed or completely enclosed within the final molded part. The apparatus comprises a mold having at least one cavity, at least one resin injection channel and at least one ejectal
10 means. A loading device is provided in the mold for introducing the non-molded part into the cavity before molding occurs. A stabilizing device is provided in the mold to position the non-molded part at the precise position within the mold while injection molding occurs. In one embodiment, the loading device is a bushing and the stabilizing device is an opposing pair of
15 pins disposed within opposing pin channels. The bushing is connected to one of the pin channels at a position between the cavity and the pin at its retracted position, such that the non-molded part can be pushed by the extending pin into the cavity. In the most preferred embodiment, the loading bushing is connected to a loading channel having a loading pin. The loading
20 channel is connected to one of the pin channels at a position between the cavity and the pin at its retracted position.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front view of the fixed half of the mold according to one embodiment of the present invention.

Figure 2 is a front view of a moving half of the mold according to one
5 embodiment of the present invention.

Figure 3 is a traverse cross-sectional view in one direction of the mold according to one embodiment of the present invention.

Figure 4 is a traverse cross-sectional view in a different direction of the mold according to one embodiment of the present invention.

10 Figure 5 is a traverse cross-sectional view in one direction of the mold according to another embodiment of the present invention.

DESCRIPTION OF THE INVENTION

The present invention provides the injection molding apparatus and method for producing molded parts containing embedded non-molded parts. The molded part may be made from any material that is used for injection molding. The non-molded part may be of any material and shape which can withstand the mold injection process, such as metallic or ceramic parts. The examples described below are of the production of a molded plastic with a metal ball bearing partially embedded inside using a horizontal mold injection machine.

Figure 1 shows the front view of the fixed half of a mold 21 according to one embodiment of the present invention. The sprue bushing 20 allows the molten resin to enter the mold cavity via runners 22. The sprue bushing, the runners and the gate 25 are considered parts of the loading channel.

Figure 2 shows the front view of the corresponding moving half 23 of the mold. Runners and gates allow the molten resin to reach the cavity 24. The embodiments shown in all the figures contain four cavities to produce four identical molded parts. In this example, each cavity consists of a central body 26, a blunt wing 28 and a sharp wing 30. For the ease of understanding, all the description below refer to the making of a molded part in one cavity. The use of multiple cavities, multiple loading channels and multiple stabilizing devices is within the scope of the present invention and can be achieved by one skilled in the art based on the teaching disclosed herein.

In order to allow a small metal ball bearing to be introduced into the cavity, a loading bushing 32 is provided in the moving half 23 of the mold as

shown in Figure 3. The loading mechanism in this example is operated by pneumatic mechanisms in which a puff of pressurized air is used to blow the ball bearing through the bushing and into a first pin channel 34. For a metal ball of 2mm diameter, the inner diameter of the loading bushing may be 2.2mm. A first pin channel 34 containing a first pin is also provided in the moving half 23. This first pin channel is connected to the loading bushing, preferably at an angle of 20-45°. In this example, the angle is 20° as shown by reference numeral 36. This is to insure that the small metal ball sits properly on a corresponding small dent at the tip of the first pin. However, other angles of between 0-80° may be used depending on the size, shape and material of the non-molded part. An opposing second pin channel 38 containing a second pin is provided in the fixed half 21 of the mold. In this example, the base of first pin 41 is connected to hydraulic means well known in the art, and the second pin is spring loaded. Figure 3 shows the first and the second pins in the extended position with the tip of the base extending into cavity 24. In the retracted position, the base 41 of the pin is pulled back as indicated by arrow 43. The advantage of using hydraulic means is that it can withstand high pressure. Since the cavity is in the moving half of the mold and the plastic material is injected against the first pin of the moving half, it experiences the greatest injection force as the resin is injected into the cavity. As a result, using hydraulic means for the extension of the first pin is preferred. On the other hand, the second pin does not experience as great a force, and therefore a spring is sufficient to maintain the second pin in the extended position. Other means for extending and retracting the pins may be used, depending on the pressure and positioning of the pins and resin injection channel. For example, mechanical means may be used, or multiple

5 springs may be used for the first pin to account for the greater injection force experienced. The tip of the first pin is adapted to retain the ball bearing securing at a precise position in the cavity. This may be achieved by shaping the tip into a cup shape to correspond to the shape of the ball bearing. As

10 mentioned previously, the specific example describe here is for a molded part with a partially exposed ball bearing. The inner surface of the cup corresponds to the protected surface on the ball bearing which will be exposed after the molding process is complete. The diameter of the first pin is 2.1mm. The diameter of the cup-shaped tip is 2mm. This cup-shaped tip

15 prevents the molten resin from forming around the protected surface of the ball bearing, thereby creating the opening in the final molded product wherethrough the ball bearing is exposed. The second pin engages the ball bearing on the side which will be embedded after the molding process. Therefore, the diameter of the traverse cross section of the second pin is

20 preferably very small, e.g. 0.5 mm to 1.5 mm diameter to insure that only a very small channel is created by the second pin after molding is completed and the second pin is withdrawn. The tip of the second pin may be concave in shape, but should not be larger than the pin itself if the pin is to be withdrawn without damaging the molded part after molding. The final product

25 would therefore have the ball bearing partially embedded with only a very small channel in the plastic.

In the preferred embodiment, the loading bushing is connected to a distribution device (not shown in figure), having a storage device to store the metal ball bearing and transfer means to transfer the metal ball bearing to

25 the loading bushing. The storage device may be any conventional storage systems, such as a hopper. An example of the transfer means is a singulator,

which releases individual ball bearing into the loading bushing. Pneumatic means are attached to the singulator to use compressed air to force the ball bearing through the loading bushing and into the first pin channel.

Figure 4 shows the mold cavity **24**, first pin channel **34**, the second pin channel **38** and ejectal pins **44** which are used to eject the molded part out of the mold. Cooling channels **46** are provided in both the fixed half **21** and moving half **23** of the mold to cool the mold material after it is injected into the mold.

In the preferred process, the mold is closed and the distribution device releases one ball bearing into the loading bushing. Then the first pin, which is retracted in a resting position, is extended towards the junction between the loading bushing and the first channel. As the ball bearing rolls through the junction, the first pin pushes it through the first pin channel. At the same time, the second pin is extended into the mold cavity to meet the ball bearing as it enters the cavity. The ball bearing is thus gripped between the first and the second pin, and is then positioned at a pre-determined position within the cavity. Molten resin is then injected into the cavity via a sprue bushing **20**. Then cooling water is circulated from the cooling channels **46** to cool the mold and allow the molten resin to form plastic. Once the molded part is formed, the first and second pins are withdrawn from the cavity. The moving half of the mold is withdrawn and the plastic is ejected from the mold cavity by the ejectal pins.

In the most preferred embodiment, an additional loading pin disposed within a loading channel **50** is provided as shown in Figure 5. In this embodiment, one end of the loading channel is connected to the first pin

channel, while the other end contains the retracted loading pin. The loading bushing is connected to the middle section of the loading channel, preferably with angle 52 being less than normal. Angle 52 is most preferred to give the shortest loading bushing such as 45°. The loading pin is controlled by
5 pneumatic means including a pneumatic cylinder 56. The pneumatic cylinders are fixed to the moving half by brackets 58. During operation, the distribution device transfers one ball bearing into the loading channel via the loading bushing by pressurized air. The loading pin is then extended into the loading channel to push the ball bearing to the first pin channel. The
10 subsequent process is the same as described above.

While the present invention has been described particularly with references to Figs 1 to 5 with emphasis on a system to produce a molded thermal plastic part with a metal ball bearing using a horizontal mold injection machine, it should be understood that the figures are for illustration
15 only and should not be taken as limitation on the invention. The present invention is versatile, and can be adapted for use with a vertical mold injection machine. In addition it is clear that the method and apparatus of the present invention has utility in many applications where automatic molding is required. It is contemplated that many changes and modifications may be
20 made by one of ordinary skill in the art without departing from the spirit and the scope of the invention described.

**CLAIMS**

- 1 1. An apparatus for injection molding comprising :
 - 2 a) a mold having a fixed half, a moving half, a cavity, a resin
 - 3 injection channel and ejectal means;
 - 4 b) loading device provided in said mold for introducing a non-
 - 5 molded part into said cavity; and
 - 6 c) a stabilizing device provided in said mold and adapted for
 - 7 positioning said non-molded part in said cavity.
- 1 2. An apparatus for injection molding according to claim 1 wherein said
- 2 loading device is a loading bushing.
- 1 3. An apparatus for injection molding according to claim 2 wherein said
- 2 stabilizing device is a pin disposed within a pin channel, said pin
- 3 coupled to extension means for pushing said pin into said cavity and
- 4 retracting said pin into said pin channel; said loading bushing
- 5 connected to said pin channel in a position between the cavity and the
- 6 fully retracted pin.
- 1 4. An apparatus for injection molding according to claim 3 wherein said
- 2 stabilizing device further comprises a second pin disposed within a
- 3 second pin channel, said second pin channels extending into said
- 4 cavity from the opposite side of the first pin channel, said second pin
- 5 coupled to extension means for extending said second pin into said
- 6 cavity opposite said first pin.



- 1 5. An apparatus for injection molding according to claim 1 wherein said
2 loading device is a loading bushing connected to a loading channel
3 having a loading pin, said loading pin coupled to extension means for
4 pushing the tip of said pin into said first pin channel.
- 1 6. An apparatus for injection molding according to claim 5 wherein said
2 stabilizing device is a pin disposed within a pin channel, said pin
3 coupled to extension means for pushing said pin into said cavity and
4 retracting said pin into said pin channel; said loading channel
5 connected to said pin channel in a position between the cavity and the
6 fully retracted pin.
- 1 7. An apparatus for injection molding according to claim 6 wherein said
2 stabilizing device further comprises a second pin disposed within a
3 second pin channel, said second pin channel extending into said
4 cavity from the opposite side of the first pin channel, said second pin
5 coupled to extension means for extending said second pin into said
6 cavity opposite said first pin.
- 1 8. An apparatus for injection molding according to claim 1 wherein said
2 non-molded part is a metal ball, and said first and second pins have
3 tips adapted to maintain said metal ball clamped securely
4 therebetween.
- 1 9. An apparatus for injection molding according to claim 4 or 6 wherein
2 the tip of said first pin is cup-shaped and complements the shape of
3 the metal ball.



- 1 10. An apparatus for injection molding according to any of the preceding
2 claims wherein said loading bushing is connected to a distribution
3 device, said distribution device comprising a storage device for storing
4 said non-molded parts, and transfer means for transferring said non-
5 molded part into said loading bushing.
- 1 11. An apparatus for injection molding according to claim 1 wherein said
2 resin injection channel comprises at least one sprue bushing, at least
3 one runner and at least one gate.
- 1 12. An apparatus for injection molding according to claim 1 wherein said
2 ejectal means comprises at least one retractable ejectal pin.
- 1 13. An apparatus for injection molding according to claim 3 wherein said
2 loading bushing connects with said pin channel at an angle of 30-80°.
- 1 14. An apparatus for injection molding according to claim 4 wherein said
2 loading bushing connects with said first pin channel at an angle of 30-
3 80°.
- 1 15. An apparatus for injection molding according to claim 5 wherein said
2 loading bushing connects with said loading channel at an angle of 40-
3 50°.



- 1 16. An apparatus for injection molding according to any one of claims 1-9
2 wherein said apparatus contains more than one cavity, each cavity
3 having its own corresponding resin loading channel, ejectal means,
4 loading device and stabilizing device.
- 1 17. An apparatus for injection molding according to claim 1-18 wherein
2 said storage device is a hopper.
- 1 18. An apparatus for injection molding according to claim 1-18 wherein
2 said transfer means is a singulator.
- 1 19. An apparatus for injection molding according to claim 1-18 wherein
2 said singulator further comprises pneumatic means for transferring
3 said non-molded object through said loading bushing.
- 1 20. A system for injection molding, said system having a mold having a
2 fixed half, a moving half, at least one cavity, at least one resin injection
3 channel and ejectal means; a loading device provided in said mold for
4 introducing a non-molded part into the corresponding cavity; and a
5 stabilizing device provided in said mold and adapted for positioning
6 said non-molded part in a corresponding cavity, said stabilizing
7 device further adapted to be withdrawn from said cavity when injection
8 molding is complete; said system comprising the steps of :
- 9 a) closing the fixed and moving halves of the mold;
- 10 b) extending said stabilizing device to transfer said non-molded
11 part from said loading device into said cavity, said stabilizing
12 device further fixing said non-molded part in a pre-determined
13 position in said cavity;



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- 14 c) injecting molten molding material into said cavity through said
- 15 resin injection channel;
- 16 d) cooling said molten resin;
- 17 e) withdrawing said stabilizing device from said cavity;
- 18 f) opening said moving half of said mold; and
- 19 g) ejecting said molded part from said cavity.