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- (57) Claim

1. A process for injection molding an article comprising the steps of:

heating, plasticising and metering a plastics material within an injection machine, said injection machine having an injection plunger therein and being in communication via a nozzle passage with a mold arrangement comprising a mold cavity for defining the article;

injecting the plasticised material using the injection plunger through the nozzle passage into the mold arrangement;

exerting an external holding pressure using the injection machine and/or plunger on the injected material so as to compact the injected material within the nozzle passage and mold arrangement;

activating interruption means to interrupt the nozzle passage and the external holding pressure while said external holding pressure is being exerted whereby an internal pressure is exerted on the compacted material

in a closed space fixed in volume which is defined with the interruption means by only the mold cavity and the portion of the nozzle passage forward of the interruption means;

cooling the mold arrangement to thereby automatically and continuously decrease the internal pressure and to provide the article;

removing said article from the mold cavity.

13. An apparatus for injection molding articles, which comprises:

an injection machine comprising a body provided with a piston cylinder formed in the interior thereof and arranged to receive a heated plastic material for forming a first article;

an injection plunger arranged for controlled axial movement within the piston cylinder;

a hollow extension forming a nozzle passage from the piston cylinder;

a mold defining a cavity, the mold being coupled with the injection machine so as to communicate with the piston cylinder of the machine body via the nozzle passage so that controlled axial movement of the injection plunger injects the heated plastic material received within the piston cylinder under pressure from the piston cylinder through the nozzle passage and into the mold cavity; and

a valve arranged for controlled movement relative to the nozzle passage to controllably interrupt the communication between the piston cylinder and the mold cavity and to form a closed space comprising a portion of the nozzle passage adjacent to the mold cavity and the mold cavity so that the injection machine is available to begin a molding operation for a second article,

characterized in that said closed space is defined by only the nozzle passage portion, the valve and the mold cavity so that it is fixed in volume, and wherein

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the valve interrupts the nozzle passage to cause a predetermined portion of the injected material to be compacted in said fixed closed space so that the compacted material exerts an internal pressure to urge itself against the mold.

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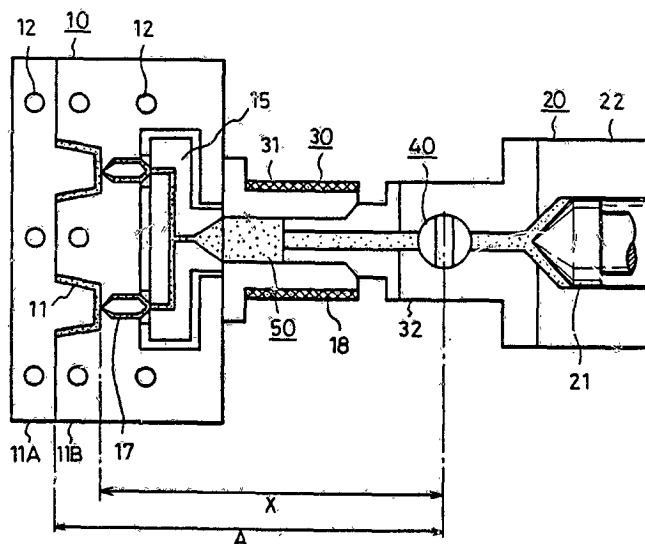
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(54) Title: PROCESS AND APPARATUS FOR INJECTION MOLDING



(57) Abstract

A system of injection molding by an injection machine with a mold comprises conventional fundamental steps including a material plasticizing and metering step, a material injecting step and a material pressure-holding step, but with an additional feature in that a nozzle passage (50) is interrupted midway therealong from communication between the interior of a machine body (22) and a mold cavity (11), after the injecting step but while the material pressure-holding step is being carried out. The material pressure-holding step is carried out first using the injection machine per se operated with a plunger (21) to exert a first non-stepped external or internal pressure on the entire injected material but second using another means for exerting a second non-stepped or stepped internal pressure on a forward portion of the injected material separated due to the nozzle passage interruption.

DESCRIPTION

TITLE OF THE INVENTION

Process for Injection Molding

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TECHNICAL FIELD

The present invention relates to an improved process for injection molding of plastic materials, particularly preferable in injection molding of precision products.

10

BACKGROUND ART

According to the prior art, an apparatus for injection molding of plastic material comprises an injection machine of a screw plunger type and a mold arrangement defining a mold cavity where a molded article is formed. The mold arrangement may be a single mold for a molded product or consist of a primary mold for a molded product and a cold runner mold for a runner. In place of the cold runner mold, the apparatus may be provided with a hot runner mold incorporated with a manifold between the single mold and the injection machine. A nozzle passage is formed between the mold arrangement and a body of the injection machine, by a nozzle, in the most simple one cavity case or a hot runner mold arrangement and the nozzle.

25

With such an apparatus, a conventional injection molding process comprises steps of:

30

having a plastic material, in every shot cycle, plasticized and metered while being heated within the machine body;

having the hot plasticized material injected under pressure into the mold cavity through the nozzle passage;

35

having the hot injected material held at least partially within the entire mold cavity under pressure while the mold arrangement is being cooled to thereby provide and freeze a molded article therein; and

having the frozen molded article removed from the



mold cavity after the mold arrangement is opened.

For example, particular steps of injection molding are indicated in Table I or II attached hereto including the above fundamental steps.

- 5 Among the important factors influencing the quality of a molded product, it has been recognized that the material pressure-holding step is one of the most critical steps. If this step is not carried out in a suitable manner, the molded products have undesired shrinkages due to short shot and/or flashes due to over-
10 packing.

The time of the material pressure-holding step depends on the time needed for cooling a molded article in the mold cavity.

- 15 With a fixed mold cooling capability and a fixed volume of the mold cavity, a thinner molded article takes a shorter time than a thicker molded article to freeze it enough for removal from the mold cavity. In this connection, the thicker molded article requires more time
20 in the material pressure-holding step, although the injecting step and the plasticizing and metering step each take the same time as for the thinner molded article.

- According to the prior art, the material pressure-
25 holding step is carried out using the injection machine with the plunger exerting an external holding pressure, subsequent to an injection pressure, on the injected material in a combination of the mold cavity and the nozzle passage against the mold cavity. The conventional
30 technology involves an external holding pressure exerted by the injection machine being controlled to form a multi-stepped pressure, rather than a non-stepped pressure, which is stepped at predetermined strokes of the plunger.

- 35 Since the function and effect of the material pressure-holding has not yet been precisely known, although there are some theories which have been



developed, there have been various attempts to improve the material pressure-holding step for a plasticized material which is viscid and elastic in the multi-stepped external pressure approach. In the conventional approach, as matter of course, there is a serious difficulty in controlling such a multi-stepped pressure in an accurate manner at predetermined precise stroke positions, since the time between the neighboring steps of the pressure is very short, on the order of 0.01 second, and with a very short distance between the strokes at the neighboring pressure steps being of the order of 0.1 mm, while an inner diameter of a barrel of the injection machine body is very large relative to such a small stroke difference. Under these circumstances the multi-stepped pressure control cannot rely on a manual operation. Therefore, the recent injection machines for producing precise products, particularly small size articles, are all equipped with an expensive computer incorporated with expensive electronic detectors for the controlled parameters. In connection with the above, such a computer is also used for controlling the plasticizing and metering step and the injection step. In the injection step, there is also adopted a multi-stepped injection method involving a multi-stepped injection speed in most of the cases.

Further, it should be noted that only after the material pressure-holding step in a shot cycle is completed, can the plasticizing and metering step be carried out for a next shot cycle. This is because the injection plunger of the machine per se is essentially engaged in said material pressure-holding step. This means that the time allowed for the plasticizing and metering step is from the completion of the material pressure-holding step to the time when the mold arrangement is opened for removing a molded article. This time is relatively short in a shot cycle period for example 4.6 sec. (34%) in the shot cycle of 14.50 sec. as



indicated in Table I, while the time of the material pressure-holding step takes 5.09 sec. (35%).

The shot cycle time (14.50 sec.) is a sum of the plasticizing and metering time (4.6 sec.), the material
5 pressure-holding time (5.09 sec.) and the other steps (5.41 sec.).

There is, of course, a strong demand for a higher productivity of a precision article due to a shorter shot cycle time in the plastic injection molding industry.

10 This demand, therefore, forces, in one way, the period of time of the material pressure-holding step to be shortened, while ensuring that the quality of molded precision article is still good. This causes not only the mold cooling capability to be improved but also the
15 computer control of the multi-stepped holding pressure and injection pressure with the associated piston strokes to be improved with higher accuracy to harmonize with the improved mold cooling, with the result that the computer control per se is obliged to be a more sophisticated or
20 complicated one with a higher cost incurred in computer equipment. At the present time, the following statement is by no means an exaggeration. The cost of the computer occupies a large part of the cost incurred in production of the injection machine with the result that recent
25 machine production has become very expensive compared with the cost of the original simple injection machine used in the past, which was not equipped with a computer and ran by a simpler operation. This naturally leads to a higher cost incurred in producing molded articles.

30 In other ways, in order to reduce the production cost, various efforts to shorten the shot cycle time, of course, have been made in the industry. Such a shortened cycle time forces the time of the plasticizing and metering step to be shortened under the conventional
35 circumstances. However, a serious problem is encountered in that shortening of the plasticizing and metering step requires an increase in the plasticizing rate or



performance with an increased power supply, leading to an increased machine cost and operation cost.

Further, it should be noted that such an increased plasticizing capability of the injection machine causes the plastic material per se to be damaged by the screw plunger due to breakage of chains of a high resin polymer, while the polymeric material is being plasticized. This leads to deterioration of a molded article.

Still further, the increased plasticizing capability requires the material to be heated to a higher temperature. This leads to prolongation of the time required to cool the molded article in the mold, and thus the enhanced heating works against the attempt to shorten the shot cycle time. Due to this lower quality of the plasticized material and enhanced heating in combination, there is a certain limitation to enlarging the plasticizing capability, even if the increased cost incurred in production of such a higher performance injection machine is neglected.

DISCLOSURE OF THE INVENTION

According to the present invention there is provided a process for injection molding an article comprising the steps of:

heating, plasticising and metering a plastics material within an injection machine, said injection machine having an injection plunger therein and being in communication via a nozzle passage with a mold arrangement comprising a mold cavity for defining the article;

injecting the plasticised material using the injection plunger through the nozzle passage into the mold arrangement;

exerting an external holding pressure using the injection machine and/or plunger on the injected material so as to compact the injected material within the nozzle



passage and mold arrangement;

activating interruption means to interrupt the nozzle passage and the external holding pressure while said external holding pressure is being exerted whereby
5 an internal pressure is exerted on the compacted material in a closed space fixed in volume which is defined with the interruption means by the mold cavity and the portion of the nozzle passage forward of the interruption means;

cooling the mold arrangement to thereby
10 automatically and continuously decrease the internal pressure and to provide the article;

removing said article from the mold cavity.

Herein, the word "external pressure" indicates a pressure exerted on a material by external means, while
15 the word "internal pressure" indicates a pressure exerted after the interruption of the nozzle passage due to the compaction of the material. It may be said thus that the compacted material exerts the internal pressure itself. The internal pressure varies as the temperature changes.

20 Preferably, the process further comprises the step of heating, plasticising and metering further material for a subsequent article while said nozzle passage is interrupted.

The external holding pressure may be a stepped or
25 non-stepped external static pressure exerted by the injection plunger.

The interruption means is provided to interrupt communication between the interior of the machine body and the mold cavity thus enabling the exertion of the
30 internal pressure. Preferably, the interruption means comprises valve means incorporated with the nozzle passage.

The forward part of the nozzle passage may be formed by a hot runner mold, in which case, the injection
35 molding process may further comprise a step of sucking back hot material remaining in said hot runner mold by

expanding the volume of the closed space before the mold arrangement is opened to remove the molded article but while said nozzle passage interruption is maintained to thereby release the hot material from the compaction.

5 The forward portion of the hot material remaining in the nozzle passage may be frozen by cooling the mold arrangement and the frozen forward material portion may be melted by heat being temporarily applied after the sucking back step is completed but just before a further
10 injection.

 The instantaneous heating is preferably effected by means previously invented by the inventor i.e., a so called "Spear System". The sucking back process or means is particularly desirable in the case where the shot
15 cycle time is short and thus the mold cooling time is short. This is because if the cold material portion is not frozen enough to resist the internal pressure in the forward nozzle part then, if the sucking back is not effected to reduce the pressure, the material is likely
20 to leak out.

 When the nozzle passage interruption is released the mold cavity communicates with the interior of the machine body for the next shot, before the cold forward material end melts.

25 The external pressure exerted by the injection plunger and/or machine just prior to the nozzle passage interruption is substantially equivalent to the internal pressure just after the nozzle passage interruption.

 The nozzle passage may form a hot runner mold
30 incorporated with a manifold having a sprue inlet to which the nozzle is attached. The mold arrangement may be provided to form a primary mold for providing a molded product and a cold runner mold for providing a molded runner. The molded product and the molded runner in
35 combination forming said molded article in the mold cavity.

 The time period of said internal pressure



substep may be of longer duration than the external holding pressure step. Preferably, the nozzle passage interruption is effected upon said injection.

5 The external holding pressure and the injection pressure are preferably non-stepped pressures, but they may be, of course multi-stepped pressures as needed.

10 Upon the nozzle passage interruption, the heating plasticizing and metering step of further material may be carried out by the injection machine for a next shot or injection. In this connection, the step of heating plasticizing and metering further material is of substantially similar duration to said internal pressure step.

15 With an appropriate initial internal pressure selected, a molded article may be obtained without local shrinkage and flashes without using any external control of the holding pressure.

20 Generally speaking, this means that a computer is no longer needed for controlling the holding pressure, and if the period of the internal pressure step is longer than the external holding pressure step a computer is no longer needed to control the external holding pressure step.

25 The present invention further provides an apparatus for injection molding articles, which comprises:

an injection machine comprising a body provided with a piston cylinder formed in the interior thereof and arranged to receive a heated plastic material for forming a first article;

30 an injection plunger arranged for controlled axial movement within the piston cylinder;

a hollow extension forming a nozzle passage from the piston cylinder;

35 a mold defining a cavity, the mold being coupled with the injection machine so as to communicate with the piston cylinder of the machine body via the nozzle passage so that controlled axial movement of the



injection plunger injects the heated plastic material received within the piston cylinder under pressure from the piston cylinder through the nozzle passage and into the mold cavity; and

- 5 a valve arranged for controlled movement relative to the nozzle passage to controllably interrupt the communication between the piston cylinder and the mold cavity and to form a closed space comprising a portion of the nozzle passage adjacent to the mold cavity and the
10 mold cavity so that the injection machine is available to begin a molding operation for a second article,

characterized in that said closed space is defined by only the nozzle passage portion, the valve and the mold cavity so that it is fixed in volume, and wherein
15 the valve interrupts the nozzle passage to cause a predetermined portion of the injected material to be compacted in said fixed closed space so that the compacted material exerts an internal pressure to urge itself against the mold.

20

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described by way of example only with reference to the accompanying drawings, in which:

- 25 Figures 1 and 2 show an injection molding apparatus incorporated with a mold arrangement and provided with a valve for effecting the nozzle passage interruption;

Figure 3 shows a flow or process chart indicating the time series of injection molding processes in a shot cycle and the valve means of Figure 1; and
30

Figures 4 and 5 are qualitative diagrams showing holding pressures exerted by a conventional process and an embodiment of the present invention respectively.

35



BEST MODE FOR CARRYING OUT THE INVENTION

Figures 1 and 2 illustrate an apparatus for injection molding incorporated with a mold arrangement 10 having mold halves 11A, 11B defining at least one cavity 11 having a gate, and comprising an injection machine 20 having a single barrel type body of a piston-cylinder type provided with an injection plunger 21 therein and a hollow extension 30 therefrom including a nozzle and a nozzle passage 50 communicating between the interior of the machine body 22 and the mold cavity 11. The machine provides for having a plastic material plasticized and metered within the machine body 22 while the machine body 22 is being heated, and for having the hot plasticized material injected into the mold cavity 11 through the nozzle passage 50 and for having the injected material at least partially held within the entire mold cavity 11 under pressure. The mold halves 11A, 11B are provided with means 12 for cooling the mold arrangement 10.

According to one embodiment of the present invention, there is provided means for interrupting the nozzle passage 50 midway therealong to prevent communication between the interior of the machine body 22 and the mold cavity 11 and for providing a fixed closed space A defined by a combination of the mold cavity 11 and a predetermined portion of the nozzle passage 50 forward of the interruption means to thereby have the compacted material exert an internal pressure to urge itself against the mold cavity 11.

According to a first embodiment of the present invention, the passage interruption means comprises a valve 40 provided in the nozzle passage 50.

Regarding Figures 1 and 2, the molding apparatus 20 is a single barrel type injection machine of the screw plunger type and is incorporated with a mold arrangement 10 defining a mold cavity 11. A hot runner mold 15 incorporated with a manifold, a bored block 31 and a bored subblock 32 in combination forms a nozzle

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arrangement having the nozzle passage 50 therein communicating with the interior of a machine body 22 and the mold cavity 11. The main block 31 defines a cylinder coaxial with the injection machine 20 and the subblock 32 defines a bored piston nozzle coaxial with the injection machine 20 and is movable into the cylinder with a fixed forward stroke and is integrated with the machine body 22. The cylinder is provided with a band heater 18, and defines a forward portion of a nozzle passage section and the piston is provided with a rear portion of the nozzle passage section therein. The subblock 32 is provided with the valve 40 therein to interrupt the nozzle passage from communication between the mold cavity 11 and the interior of the machine body 22.

15 A combination of the main block 31 and the subblock 32 enables the volume of the nozzle passage 50 to be axially expanded by a rearward movement of the injection machine 20, while the nozzle passage interruption is maintained but before a molded article is removed from the mold cavity 11, with the effect that a forward portion of an injected material, exclusive a molded article, remaining in the forward nozzle passage part is sucked back so that it is released from being pressurized and compacted.

25 The runner mold 15 is provided with means 17, a so called "Spear System", for instantaneously heating the runner mold at a free forward end of the runner passage when the mold arrangement 10 is closed for an injection operation, while the mold arrangement 10 is being cooled.

30 Referring now to Figure 3, the material pressure-holding step, comprising the external and internal holding pressure steps, may firstly be carried out by the injection machine 20 exerting a first non-stepped external pressure on the injected material (I), and

35 secondly, upon the nozzle passage interruption (i) by the valve 40 be carried out by the compacted material exerting a second non-stepped internal pressure (II).



Upon the nozzle passage interruption (i), the plasticizing and metering step (III) is carried out for the next shot cycle.

Referring to Figure 3, the nozzle passage interruption (i) is released, that is the nozzle passage is opened (ii), after the mold is closed and clamped but just after the injection plunger 21 is retracted with a rear portion of the injected material separated due to the nozzle passage interruption and a fresh metered plasticized material, in combination, is sucked back into the material body 22. The nozzle passage interruption (i) is effected just after the first material external pressure-holding step (I) and is continued until just before the mold arrangement 10 is opened for removal of a cold molded article.

The plasticizing and metering step (III) which is commenced upon the nozzle passage interruption (i) can be continued at most until the nozzle passage interruption is released, that is the nozzle passage is opened (ii) for a next shot cycle. That is, the plasticizing and metering operation can be continued at most for a time ($t_1 = T - t_2$) in a shot cycle time (T), where t_2 is a relatively short time from the time when the injection is commenced to the time when the nozzle passage interruption (i) is effected and includes the first material external pressure-holding substep (I) by the injection plunger (21), following the injection.

Tables I and II below show the operational steps of injection molding carried out in a shot cycle using a conventional injection process and the process of the first embodiment of the invention (Figure 1, 2). The apparatuses are incorporated with the same mold arrangement as that for producing plastic VHS half cases (four cases and two cases per unit).

The apparatus involved in Table II has a nozzle shut-off valve for preventing the material from leaking out of the nozzle, while the first embodiment of the



present invention is not provided with such a nozzle shut-off valve. Such leaking is prevented due to a combination of the material frozen at the forward end of the nozzle passage by the mold cooling and the material
5 being sucked back. The other conventional apparatus involved in Table I has no shut-off valve.

Referring to Tables I and II, the plasticizing and metering steps (III) according to the first embodiment of the present invention for a next shot cycle are carried
10 out for about 8.5 sec. (Table I) and about 11 sec. (Table II) respectively, while the conventional plasticizing and metering steps are carried out for about 3.5 sec. (Table I) and about 4.5 sec. in shot cycle times of 14.59 sec. (Table I) and 13.50 sec. (Table II) respectively.

15 Resultant molded products have a high quality without flashes and shrinkage.

The above results are surprising in comparison with those of the prior art. This is an advantageous effect of this embodiment of the present invention where an
20 internal pressure of a plasticized material is utilized upon the nozzle passage interruption, and the plasticizing and metering step is commenced upon the nozzle passage interruption.

The injection machine may for this embodiment of the
25 invention be smaller in size and/or less powered, and may be operated at a reduced plasticizing rate compared to the injection machine used for the conventional process. The effect is obtained without any computer control.

The injection machine need not be provided with a
30 computer for controlling the first external holding pressure and may be operated with a short non-stepped first external holding pressure, and upon the nozzle passage interruption, the second material pressure-holding substep is carried out so as to have the
35 compacted material exert a second non-stepped internal pressure without the use of a computer.

As shown in Table I and II, the injection machine



according to the conventional process exerts a multi-stepped external pressure for the entire material pressure-holding step using a computer (two stepped pressure in Table I and three stepped pressure in Table 5 II).

Referring to Figure 4, according to the conventional process the external pressure exerted by the injection machine in the entire material pressure-holding step is decreased in a multi-stepped manner controlled by a 10 computer as the mold arrangement is cooled.

According to the present invention, the material pressure-holding step comprises a first substep (I) and a second substep (II) due to the nozzle passage interruption (i). (Figure 5). The first substep (I) is 15 carried out by the injection machine and the second substep is carried out by the compacted material. In the first substep (I), a first external holding pressure may be exerted by the injection plunger 21 in a non-stepped manner which does not require any computer as shown in 20 Figure 5. Following the interruption of the nozzle passage, by, for example, the valve 40 (Figures 1 and 2), a second internal holding pressure exerted by the compacted material is decreased from the first external pressure in a non-stepped manner without a computer as 25 the mold arrangement is cooled as shown in Figure 5.

To sum up, with respect to the effect on the contour quality of a molded article attained by the internal holding pressure system, embodiments of the present invention are substantially equivalent or superior to a 30 conventional external pressure system involving a sophisticated computer control. This is highlighted by the fact that the internal holding pressure-system inherently requires no computer control.

Further, the present invention is particularly 35 suitable for thicker molded articles since the material pressure-holding step required is of longer duration.



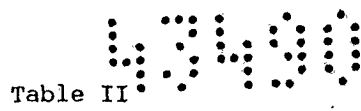


20 11 91

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Table I

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	sec
Styren Polymer VHS Half Case (4 mold Cavities) [220 ton Injection Machine with a 58 mmφ Screw Plunger]																
Injection	:	:	:		:	:	:	:	:		:	:	:	:		0.95
Holding Pressure	—	—	—	—	—	—	:	:	:		:	:	:	:		5.09
Multi-Stepped I	—	:	:		:	:	:	:	:		:	:	:	:		1.70
External II	:	—	—	—	—	—	—	—	—		:	:	:	:		3.39
Pressure III	:	:	:		:	:	:	:	:		:	:	:	:		
Mold Cooling	:	:	:		—	—	—	—	—	—	:	:	:	:		5.00
Injection Plunger Waiting	:	:	:		:	:	:	:	:		:	:	:	:		
Nozzle Shutting	:	:	:		:	:	:	:	:		:	:	:	:		
Sucking Back	:	:	:		:	:	:	:	:		:	:	:	:		3.50
Plasticizing & Metering	:	:	:								:	:	:	:		
											:	:	:	:		
											:	:	:	:		
Mold Opening Time	:	:	:		:	:	:	:	:		—	:	:	:		1.00
Molded Article Removing Time	:	:	:		:	:	:	:	:		:	—	:	:		1.75
Mold Clamping	:	:	:		:	:	:	:	:		:	:	:	—		0.80
Mold Clamping to Mold Opening	—	—	—	—	—	—	—	—	—	—	:	:	:	:		11.00
Mold Opening to Mold Clamping	:	:	:		:	:	:	:	:		—	—	—	—		3.89
One Shot Cycle Time	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14.59



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A process for injection molding an article comprising the steps of:

- 5 heating, plasticising and metering a plastics material within an injection machine, said injection machine having an injection plunger therein and being in communication via a nozzle passage with a mold arrangement comprising a mold cavity for defining the
- 10 article;
- injecting the plasticised material using the injection plunger through the nozzle passage into the mold arrangement;
- 15 exerting an external holding pressure using the injection machine and/or plunger on the injected material so as to compact the injected material within the nozzle passage and mold arrangement;
- 20 activating interruption means to interrupt the nozzle passage and the external holding pressure while said external holding pressure is being exerted whereby an internal pressure is exerted on the compacted material in a closed space fixed in volume which is defined with the interruption means by only the mold cavity and the portion of the nozzle passage forward of the interruption
- 25 means;
- cooling the mold arrangement to thereby automatically and continuously decrease the internal pressure and to provide the article;
- 30 removing said article from the mold cavity.

2. A process according to claim 1, further comprising the step of heating, plasticising and metering further material for a subsequent article while said nozzle passage is interrupted.

3. A process according to claim 2, wherein said internal pressure step is of longer duration than the external holding pressure step.



4. A process according to claim 3, wherein said step of heating, plasticising and metering further material is of substantially similar duration to said internal pressure step.

5

5. A process according to any one of the preceding claims, wherein said external pressure is a non-stepped pressure.

10 6. A process according to any one claims 1-4, wherein said external pressure is a stepped pressure.

15 7. A process according to any one of the preceding claims, wherein a hot runner mold forms a forward part of said nozzle passage.

20 8. A process according to claim 7, further comprising a step of sucking back hot material remaining in said hot runner mold by expanding the volume of the closed space before the mold arrangement is opened to remove the molded article but while said nozzle passage interruption is maintained to thereby release the hot material from the compaction.

25 9. A process according to claim 8, wherein the forward portion of the hot material remaining in the nozzle passage is frozen by the cooling of the mold arrangement, and wherein said frozen forward material portion is melted by heat temporarily applied after said sucking
30 back step is completed but just before a further injection.

35 10. A process according to claim 9, wherein said nozzle passage interruption means is released so that the mold cavity communicates with the interior of the machine body for the next injection before said frozen forward material portion melts.



11. A process according to claim 10, wherein the hot plasticised material metered for the subsequent article is substantially equivalent to that of the molded article.

5

12. A process substantially as hereinbefore described with reference to Figures 1-3 and 5 of the accompanying drawings.

10 13. An apparatus for injection molding articles, which comprises:

an injection machine comprising a body provided with a piston cylinder formed in the interior thereof and arranged to receive a heated plastic material for forming
15 a first article;

an injection plunger arranged for controlled axial movement within the piston cylinder;

a hollow extension forming a nozzle passage from the piston cylinder;

20 a mold defining a cavity, the mold being coupled with the injection machine so as to communicate with the piston cylinder of the machine body via the nozzle passage so that controlled axial movement of the injection plunger injects the heated plastic material
25 received within the piston cylinder under pressure from the piston cylinder through the nozzle passage and into the mold cavity; and

a valve arranged for controlled movement relative to the nozzle passage to controllably interrupt the
30 communication between the piston cylinder and the mold cavity and to form a closed space comprising a portion of the nozzle passage adjacent to the mold cavity and the mold cavity so that the injection machine is available to begin a molding operation for a second article,

35 characterized in that said closed space is defined by only the nozzle passage portion, the valve and the mold cavity so that it is fixed in volume, and wherein



the valve interrupts the nozzle passage to cause a predetermined portion of the injected material to be compacted in said fixed closed space so that the compacted material exerts an internal pressure to urge
5 itself against the mold.

14. The apparatus of claim 13, further comprising a hot runner mold arranged downstream of the valve and forming a portion of the nozzle passage
10

15. The apparatus of claim 13 or 14, comprising a heater for instantaneously heating a part of the material at a gate of the mold.

15 16. An apparatus for injection molding articles substantially as hereinbefore described with reference to the accompanying drawings.

20 DATED this 9th day of April, 1992.

SEIKI CORPORATION CO., LTD.

By their Patent Attorneys

25 DAVIES COLLISON CAVE

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Fig. 1

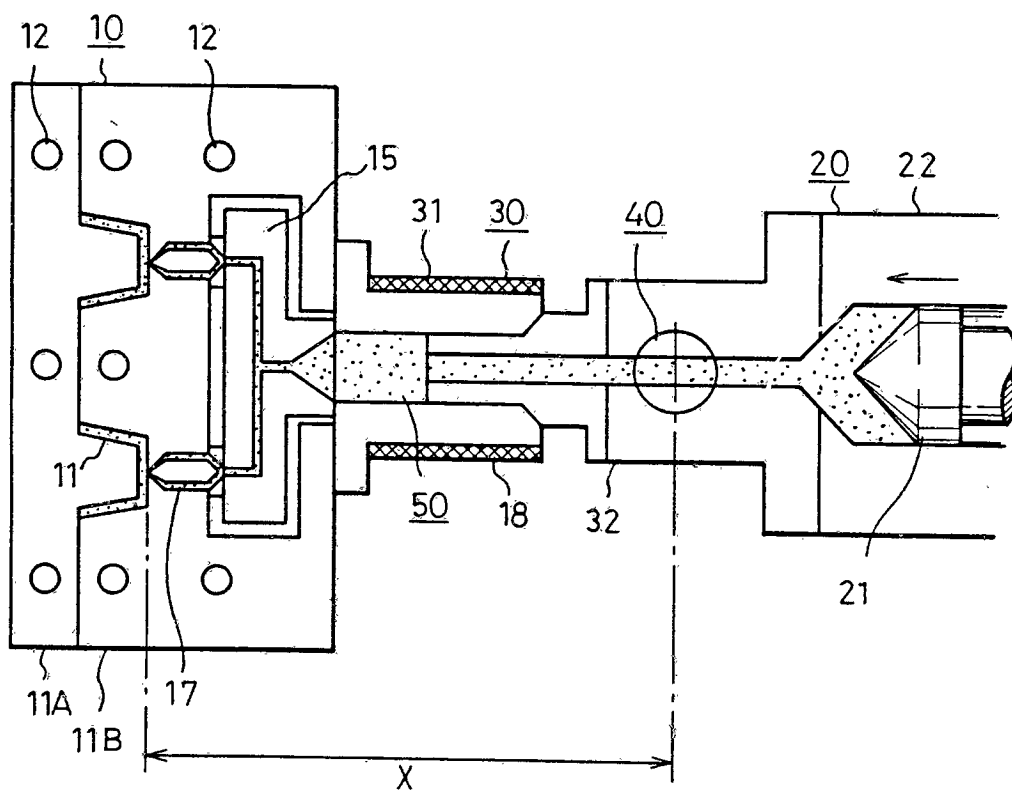
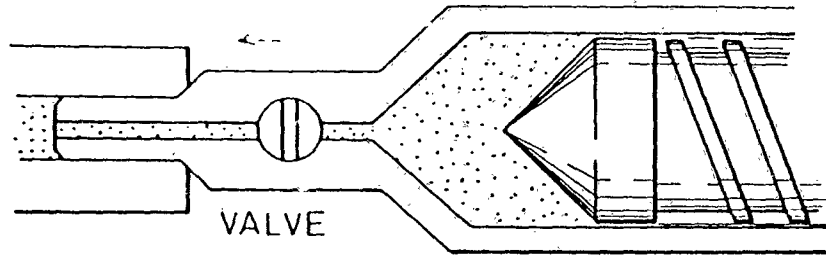
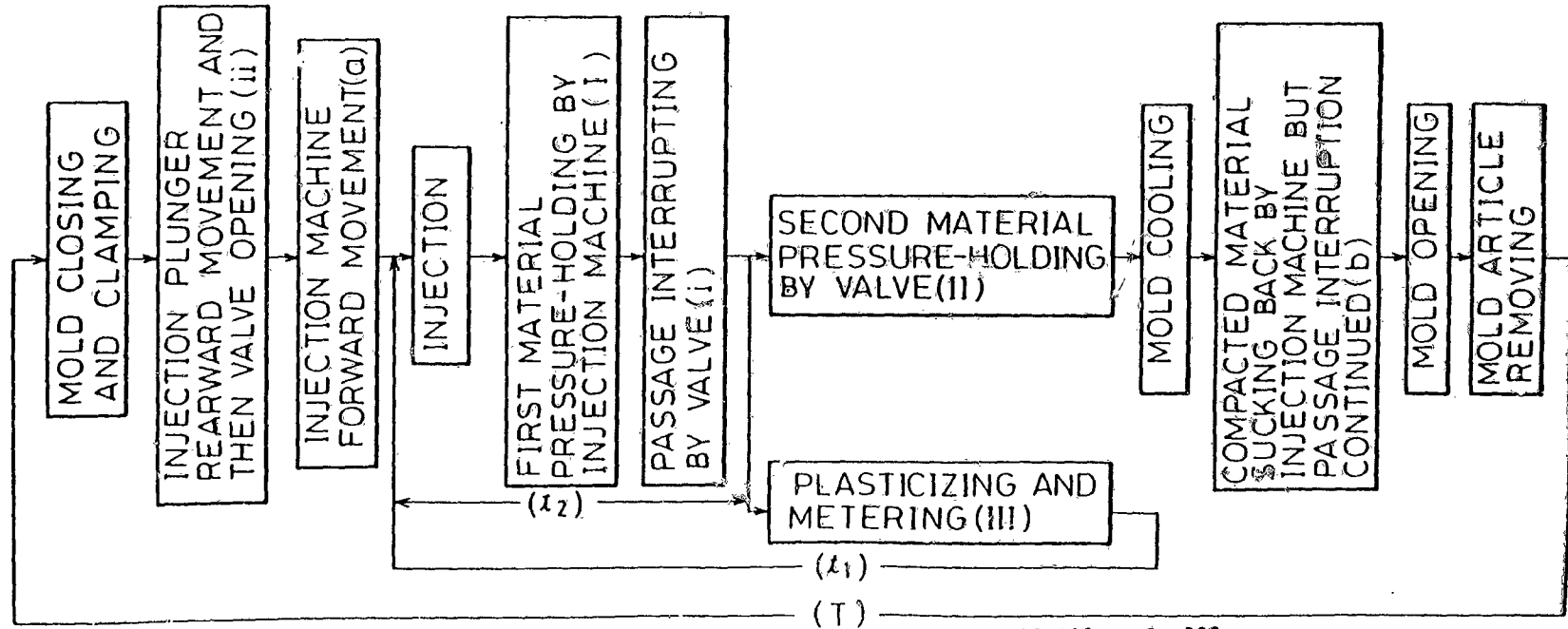


Fig. 3



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Fig. 4

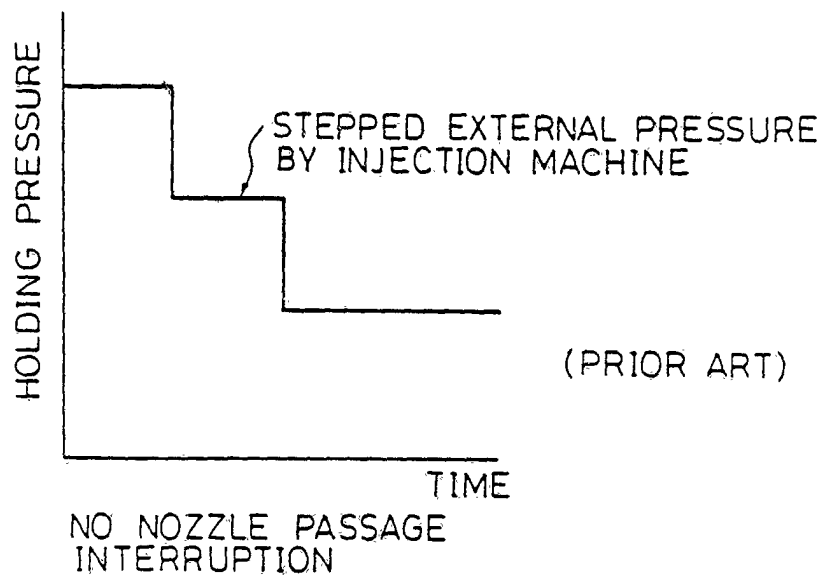
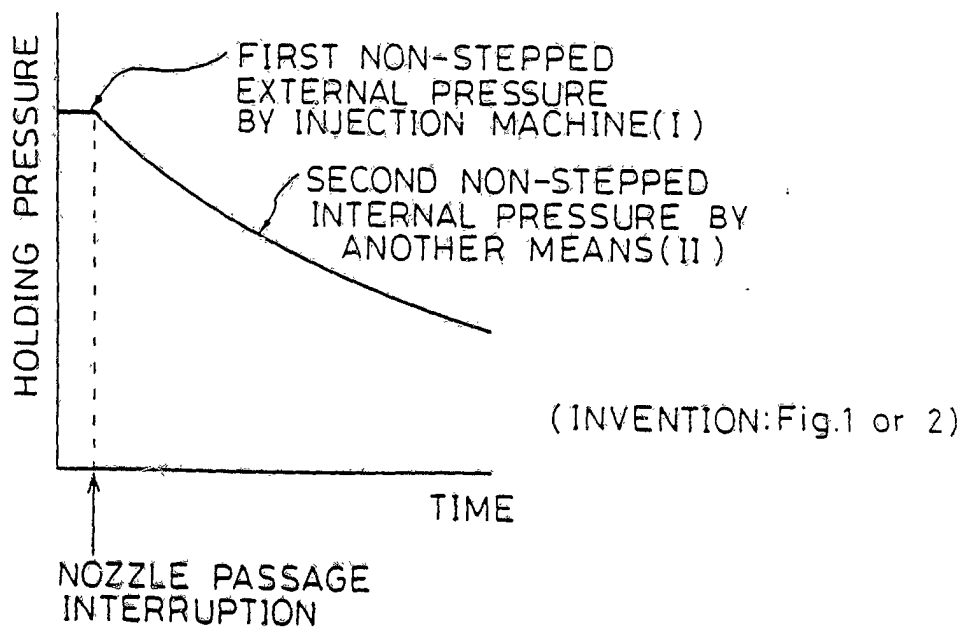


Fig. 5



INTERNATIONAL SEARCH REPORT

PCT/JP 89/01052

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 B29C45/57		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	B29C	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	EP,A,0204133 (KRUPP KAUTEX) 10 December 1986 see the whole document	1-3, 5, 7, 13-16, 23, 29, 36 32, 33
Y	---	
X	US,A,4632652 (FARRELL) 30 December 1986 see the whole document	1, 14-16, 19, 23, 29, 35, 36 30
Y	---	
X	US,A,4722679 (FARRELL) 02 February 1988 see the whole document	1, 14-16, 19, 2 ¹ , 29, 36

	-/--	
¹⁰ Special categories of cited documents : ¹⁰ ^{"A"} document defining the general state of the art which is not considered to be of particular relevance ^{"E"} earlier document but published on or after the international filing date ^{"L"} document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) ^{"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 ^{"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		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
3 03 JANUARY 1990	06.02.90	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	C.D. v.d. Vliet 	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	GB,A,2116903 (EMHART INDUSTRIES) 05 October 1983 see the whole document	1, 14-17, 19, 23, 29, 31, 36

X	US,A,4256689 (GARDNER) 17 March 1981 see column 4, line 21 - column 5, line 34; figures 6-12	1, 14-16, 23, 29, 36
Y		30

X	GB,A,888448 (WINDSOR) 31 January 1962 see page 2, lines 29 - 101; figures 1, 2	1, 14-16, 23-26, 36

X	GB,A,2172240 (BARRETT) 17 September 1986 see page 3, lines 2 - 39; figure 1	1, 18, 23, 29, 38

Y	FR,A,2125496 (TSUTSUMI) 29 September 1972 see the whole document	32

Y	US,A,4164523 (HANNING) 14 August 1979 see the whole document	33

P,Y	FR,A,2620646 (SANRI K.K.) 24 March 1989 see the whole document	33

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

PCT/JP 89/01052
SA 31669

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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30/01/90

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0204133	10-12-86	DE-A- 3516179	06-11-86
US-A-4632652	30-12-86	None	
US-A-4722679	02-02-88	US-A- 4749536	07-06-88
GB-A-2116903	05-10-83	AU-A- 1266083	22-09-83
		CA-A- 1202459	01-04-86
		DE-A- 3307586	29-09-83
		FR-A- 2523506	23-09-83
		JP-A- 58171929	08-10-83
		US-A- 4784819	15-11-88
US-A-4256689	17-03-81	None	
GB-A-888448		None	
GB-A-2172240	17-09-86	None	
FR-A-2125496	29-09-72	AU-B- 466651	09-08-73
		AU-A- 3865972	09-08-73
		CA-A- 971320	22-07-75
		CH-A- 535118	31-03-73
		DE-A, C 2207001	24-08-72
		GB-A- 1382800	05-02-75
		US-A- 3800027	26-03-74
US-A-4164523	14-08-79	DE-A, C 2640607	22-12-77
		CA-A- 1102985	16-06-81
		CH-A- 626563	30-11-81
		FR-A, B 2364111	07-04-78
		GB-A- 1549940	08-08-79
		JP-A- 53033258	29-03-78
		NL-A- 7709858	13-03-78
		US-A- 4139177	13-02-79
FR-A-2620646	24-03-89	JP-A- 1075218	20-03-89
		DE-A- 3831562	06-04-89
		GB-A- 2209990	01-06-89

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