

Description

TECHNICAL FIELD

This invention relates to a method of plastic injection molding, and, more particularly, a method in which pressurized gas is used to assist in the molding process.

BACKGROUND ART

The use of pressurized gas to assist in a conventional plastic injection molding process is believed to have been first made commercially practicable by the invention of Friederich disclosed in U.S. Patent No. 4,101,617, issued July 18, 1978, which discloses a method of plastic injection molding according to the preamble of claim 1. The Friederich patent addressed the problem of molding hollow shaped bodies in a single injection molding operation, and taught a practicable method of introducing compressed gas along with, or just after, the injection of molten plastic resin into the article-defining cavity. Moreover, the Friederich patent solved the concern of de-pressurizing or relieving the molded article by nozzle separation. The early work of Friederich was directed to the molding of such utilitarian articles as clear plastic architectural bricks and the like. More recently, the patented Friederich process has been adapted to the molding of hollow plastic articles of various shapes and dimensions.

In its early years, the use of pressurized gas in assistance to a conventional plastic injection mold process was not recognized for all of the functional attributes which it is known to enjoy today. More specifically, during those early years, the industry gave greater focus to the use of structural foam as a specialty process for molding relatively thick-sectioned articles which would be light in weight and have acceptable surface finish, i.e., avoid sink marks associated with the conventional plastic injection molding. The range of potential applications of structural foam molding of thermoplastic materials was limited, however, due to certain inherent features of such process. Among such features included, the relatively long cycle times required to cool the plastic in the mold (the foam cells serve to insulate heat transfer), and the problem of surface finish (splay, blister and swirl) associated with the foamed, molten plastic resin contacting the cool surface walls of the article-defining cavity.

In recent years, attention has returned to the use of gas assistance with conventional plastic injection molding to attain the product quality and productivity which had been hoped for with structural foam molding. The features of surface quality, lower clamp tonnage, rapid cycle times, weight

reduction, material saving and minimization of part distortion or warpage can all be obtained with proper utilization of gas assistance with a conventional plastic injection molding process. The paper titled "GAS-ASSISTED INJECTION MOLDING -- THE NEW THERMOPLASTIC MOLDING TECHNOLOGY FOR EXTERIOR BODY PANELS" by Dr. Ken C. Rusch, presented at the 1989 meeting of the Society of Automotive Engineers on March 2, 1989, discusses in greater detail the relevant history of the use of gas-assistance in connection with plastic injection molding.

The impetus for the present invention was the inventor's assignment to realize the successful plastic injection molding of an automobile headlamp cover. This type of cover pivots between an open position to reveal the headlamp lens, and a closed position to conceal the headlamp lens to enhance the design aesthetics and aerodynamic profile of the automobile. The structure of the headlamp cover comprises a substantially planar panel which is intended to appear flush and continuous with the front end body panels when the cover is in the closed position. The planar section is mounted by a pair of flange arms integrally joined at the opposed ends. Each flange arm extends perpendicularly to the substantially planar cover portion.

The inventor's objective was to realize the headlamp cover as a plastic molded part to replace a conventional die-cast metal part. The die-cast metal part is relatively heavier and requires a higher rated motor or actuator to move the headlamp cover between its open and closed positions. Also, the die-cast cover has thermal cycling problems, and cannot withstand passage through the factory paint ovens where temperatures may reach or exceed 400°F without experiencing permanent deformation. The die-cast metal part thus has the further drawback of requiring installation in a secondary, off-line operation which added to the cost and complexity of automated automobile assembly.

There were several practical problems facing the inventor in realizing the headlamp cover design in a plastic molded piece. First, the exterior surface of the substantially planar portion of the headlamp cover had to be "Class A" quality and be paintable in the automated line. Any surface degradation due to sink marks, blemishes or other imperfections were unacceptable for commercial standards. Second, the headlamp cover could not have warpage or distortion across its substantially planar surface no matter the microscopic smoothness of the surface. Third, the dimensional integrity of the flange arms was critical to ensure safe and consistent mechanical operation of the headlamp cover when actuated between its closed and open positions. Fourth, the part had to be filled out, i.e., the part design had to be such that it could be filled out on

a regular production basis within processing temperatures which do not cause degradation of the resin composition and at injection pressures which do not create molecular shear forces in the resin which would reduce the mechanical strength of the finished article. The part had been exhaustively molded in conventional plastic injection molding processes on a prototype development basis without desired success.

The dilemma facing the inventor can be simply put as follows: (i) too little plastic injection pressure would risk inferior surface quality and non-fillout of the part; (ii) too high of an injection pressure and/or injection speed would risk molecular shearing of the material and cause molded-in stress which is manifested by distortion and lack of strength; and (iii) too great of a resin temperature would decrease the viscosity of the molten resin but risk exceeding the material processing temperature and cause material degradation and dehomogenization of any filler material, such as impregnated glass.

The solution to the inventor's dilemma proved to be the use of gas-assistance in plastic injection molding the headlamp cover. However, the design did not admit to having the gas enter the article-defining cavity and form hollow portions or channels in the finished part. The substantially planar portion of the headlamp cover was required to be of continuous cross-sectional thickness, and the presence of gas channels, as well as the possibility of gas permeation outside of the channels, was unacceptable as a matter of customer dictated part design. Moreover, after a number of attempts to design the headlamp cover part with gas channels in selected positions, it was found that the mechanical strength of the cover may be compromised if gas channels were present, especially at the integral lines of joinder of the flange arms to the cover panel. The inventor's solution then turned to the novel type of gas assisted plastic injection molding process which is summarized presently.

DISCLOSURE OF THE INVENTION

The present invention is a plastic injection molding process which uses a first charge of pressurized gas to assist in the formation of the molding in the article-defining cavity, but in which the first charge of gas does not enter into the article-defining cavity. In this application, the first charge of gas is injected into a mold and is selected to be of quantity and pressure sufficient to enter into a volume substantially contiguous to the article-defining cavity to assist in the fillout of the cavity with molten resin.

The molten plastic may be injected at a pressure which does not introduce molded-in stresses into the plastic at the molecular level. The pressure

of the gas in the volume continuous to the article-defining cavity permits a direct and controlled pressure application on the fluent resin in the article-defining cavity. The gas assistance thereby aids in the surface quality by maintaining intimate contact of the resin with the mold walls defining the cavity while the resin cools, i.e., shrinkage of the resin is resisted. A further advantage of the present inventive process is that depressurization or relieving the gas pressure of the mold does not affect the plastic within the article-defining cavity. The introduction of the gas may be accompanied by various means well known in the art.

The substantially contiguous volume containing the gas may be a runner in the mold, and the relieving step may be accomplished by separating the mold halves and permitting the runner to self-rupture. Alternatively, the runner may be pierced, sheared or opened by a like mechanical operation to relieve the pressure in the mold, or by other means well known in the art.

A second charge of pressurized gas may be introduced into the mold at a location remote from a first resin flow path by which the resin entered the article-defining cavity. The second charge of gas is of a pressure and quantity sufficient to enter the article-defining cavity but not into the first resin flow path. In the embodiment of Figures 9 and 10, the second charge of gas is directly introduced into the article-defining cavity. In the embodiment of Figures 4 through 8, the second charge of gas is introduced into a resin reservoir in communication with the article-defining cavity by a second resin flow path. Alternatively, when introduced to the resin reservoir, the second charge of gas is of a pressure and quantity sufficient to enter the resin reservoir and the second resin flow path but not into the article-defining cavity.

Further objects and features of the present invention will be made known in the following description of the best mode for carrying out the invention.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a process flowchart showing operative steps of the novel molding process of the present invention;

FIGURE 2 is a schematic view of a full-shot molding specimen produced in accordance with the process steps of Figure 1;

FIGURE 3 is a side view of a bulbous runner and lens cover of Figure 2;

FIGURE 4 is a top plan view of a molding made wherein first and second charges of pressurized gas are utilized in forming the molding;

FIGURE 5 is a sectional view taken along lines 5-5 of Figure 4 to illustrate the cavities formed in

the molding and a gas pin in its gas inject position;

FIGURE 6 is a sectional view taken along lines 6-6 of Figure 4;

FIGURE 7 is a sectional view taken along lines 7-7 of Figure 4;

FIGURE 8 is a side view, partially broken away and in cross section, with the gas pin of Figure 5 in its retracted position;

FIGURE 9 is a side view, partially broken away and in cross section of another embodiment of the invention wherein the second charge of pressurized gas is injected directly into the article-defining cavity and wherein a gas pin is in its gas inject position; and

FIGURE 10 is a view similar to Figure 9 except the gas pin is in its retracted position to vent the molding.

BEST MODE FOR CARRYING OUT THE INVENTION

Figure 1 discloses the general sequence of steps involved in carrying out the method of the present invention. Figure 2 is a schematic illustration of an exemplary full-shot molding, indicated generally at 20, of a headlamp lens cover of the type referred to in the proceeding discussion. The following description of the invention will correlate the method steps of Figure 1 with corresponding structure of Figure 2 to facilitate the disclosure. As a prefatory note, the general principles of gas-assisted injection molding are disclosed in the basic patent to Friederich, U.S. Patent No. 4,101,617, issued July 18, 1978. The present invention is an improvement based on the Friederich disclosure which addressed the basic problems of coordinating the introduction of molten plastic and pressurized gas into the mold and thereafter venting the interior of the hollow molded article on a predictable, repeatable basis to produce articles with superior surface quality on a commercial basis.

With reference to Figure 1, in step 10, a charge or amount of molten plastic resin is injected into an injection aperture of a mold in an injection molding system. In the application of Figure 2, the quantity of resin is sufficient to fill out the article-defining cavity of the mold and a portion of the volume defined by a sprue 24 and a runner 26 of the molding 20. The sprue 24 and the runner 26 help to define a first resin flow path which extends between the injection aperture and the article-defining cavity.

In this case, the article-defining cavity is the volume along reference line "A" which defines the shape of the finished article. The finished article is a headlamp lens cover indicated generally at 22. The cover 22 comprises a substantially planar pan-

el 30 which has a perimeter frame 32 of thicker cross section. A pair of mounting flanges 34a and 34b are attached integrally at the opposite lateral ends of the panel 30 by respective webs 36a and 36b. The center portions of the mounting flanges 34a and 34b include notches 38a and 38b configured to couple with actuator arms on the servo mechanism which would pivot the lens 22 between its open and closed positions.

The exterior surface of the planar panel 30 must be free of imperfections to meet automotive company standards on Class A surface finish. Also, the panel must be free of warpage or deformation over its surface area to ensure proper fit and appearance when assembled on the automobile.

The mounting flanges 34a and 34b must be integrally joined to the panel 30 in true perpendicular relation. A deviation from perpendicular relation will bias the mounting flanges 34a and 34b from a proper mechanical coupling to the actuator arms for the headlamp lens cover 22. Moreover, the mounting flanges 34a and 34b must have a reasonably strong mechanical connection to the panel 30 through-webs 36a and 36b.

Accordingly, in step 10, the charge of plastic resin is injected at a pressure sufficient to nominally fill out the article-defining cavity without any gas entry into the cavity but not so great as to introduce microscopic stresses within the plastic which will cause warpage upon removal of the article from the mold cavity or during subsequent thermal cycling of the article. The temperature of the plastic charge is within the range of processing temperatures for the resin composition to ensure sufficient fluidity of the plastic charge. However, the plastic injection temperature cannot be so great as to cause shearing or burning of the resin composition, and consequent degradation of the material, including dehomogenization due to separation of filler materials.

In step 12, a first charge of pressurized gas is injected into the injection aperture through the sprue 24 and into the runner 26. However, the charge of gas is selected to be of a pressure and quantity sufficient to avoid entry of the gas into the article-defining cavity. The volume available to the gas is indicated schematically at 28. The specific pressure and quantity of gas required must be determined on a job-by-job basis through an iterative trial procedure in the course of normal trial moldings.

In the case of the headlamp lens cover 22, the runner 26 is shaped to accommodate a substantial quantity of pressurized gas to assist in the molding process. As illustrated in Figure 3, the runner 26 may have a bulbous cross section, i.e. somewhat in the shape of an inverted water droplet, to facilitate the entry of gas into the runner and containment

from the article-defining cavity.

The presence of pressurized gas in the volume indicated at 28 assists in the fill out of the article-defining cavity with molten resin to avoid the need for relatively high plastic injection pressure.

In step 14, the pressurized gas is maintained in the volume 28 while the plastic solidifies within the article-defining cavity. The presence of the pressurized gas during solidification urges the plastic into intimate contact with the walls of the article-defining cavity to promote surface quality. The gas pressure counters the normal tendency of the plastic to shrink while cooling and leave blemishes in the surface of the finished article.

In step 16, the molding 20 is depressurized by relieving the pressure in the molding 20 and the finished article is removed. The depressurization can occur autogenously by separation of the mold halves and self-rupturing of the runner 26. The self-rupturing facilitates the molding process by avoiding the need for a separate depressurization operation. For example, in some types of gas-assisted molding processes, the interior of the molding is vented through a gas recovery step involving timers, valves and a reservoir. In this case, the bulbous cross-sectional shape of the runner 26 admits to self-rupture upon separation of the mold halves.

Alternatively, the molding 20 may be depressurized before separation of the mold halves by piercing, shearing or a like mechanical operation applied to the sprue 24 or the runner 26 or by nozzle retraction.

Upon depressurization or relieving the molding, the full-shot molding 20 is removed from the mold. The appendages of the runner 26 and the sprue 28 may be separated from the finished article 22 in accordance with conventional operations.

Referring now to Figures 4 through 10, a second charge of pressurized gas may be introduced into the mold at a location remote from a first resin flow path by which the resin entered the article-defining cavity.

In the embodiment of Figures 9 and 10, the second charge of gas is directly introduced into the article-defining cavity. In the embodiment of Figures 4 through 8, the second charge of gas is introduced into a resin reservoir 40 in communication with the article-defining cavity by a second resin flow path. The second charge of gas is either of a pressure and quantity sufficient to enter the article-defining cavity but not into the first resin flow path or alternatively, when introduced to the resin reservoir 40, is of a pressure and quantity sufficient to enter the resin reservoir 40 and the second resin flow path but not into the article-defining cavity.

As shown in Figures 4 through 8, first and second charges of pressurized gas are introduced

into the mold at substantially the same time to make a single article 22'. Parts with the same or similar structure or function to the parts of Figures 1 - 3 are given a single prime designation whereas such parts are given a double prime designation in Figures 9 and 10. The resin reservoir or spillover 40 is in communication with the article-defining cavity which defines the plastic article 22' produced. The resin reservoir 40 helps to define a second resin flow path which extends from the article-defining cavity to allow molten plastic resin to flow therefrom to the resin reservoir 40.

As best shown in Figure 5, the second charge of gas is introduced into a thick position 23 of the article 22' through a retractable gas pin 25 shown in its gas inject position. The gas preferably flows through the pin 25 into the resin reservoir 40 and along the second resin flow path. The gas is of a pressure and quantity to enter the second resin flow path and thence into the article-defining cavity but not into the first resin flow path.

Alternatively, it may not be desired that the second charge of gas enter the article-defining cavity (i.e., due to the shape and size of the part). In such a case, the pressure and quantity of the second charge of gas is adjusted so that it only enters the second resin flow path.

Figures 5 and 6 illustrates the extent to which the first charge of gas entered the runner 26' from the sprue 24' but not the article 22'.

Figure 8 illustrates the gas pin in its retracted position to allow gas pressure to evacuate the article 22'.

Figures 9 and 10 illustrate a modified retractable gas pin 25' (similar to gas pin 25) for injecting a second charge of pressurized gas directly into a thick portion 23' (similar to thick portion 23) of a plastic article 22''. In Figure 9, the pin 25' extends into the thick portion 23' whereas in Figure 10 the pin 25' is retracted to allow gas pressure to evacuate the molding. The second charge of gas is of a pressure and quantity to enter the article-defining cavity but not into the first resin flow path by which the molten resin plastic entered the cavity.

The invention has been described in an illustrative manner, and, it is to be understood that, the terminology which has been used is intended to be in the nature of the words of description, rather than of limitation.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.



Claims

1. A method for the use of gas-assistance in the molding of a plastic article (22) in an injection molding system including a mold having an injection aperture, the method comprising the steps of:

injecting an amount of molten plastic resin sufficient for the preparation of the plastic article (22) through the injection aperture and along a resin flow path (24, 26) which extends from the injection aperture to an article-defining cavity in the mold;

injecting a charge of pressurized gas through said resin flow path (24, 26) into the mold, maintaining the gas charge under pressure within the mold while the plastic resin solidifies within the article-defining cavity; and

relieving the gas pressure within said flow path;

characterized in that said method comprises the step of

injecting said charge of pressurized gas into the mold at a pressure and quantity sufficient to enter the resin flow path but not into the article-defining cavity.

2. The method as described in claim 1 for injection molding of a plastic article (22) having at least one substantially planar portion (30), said resin flow path (24, 26) including a portion which is substantially contiguous to a portion of the article-defining cavity corresponding to the substantially planar portion (30), the method comprising the steps of:

injecting a charge of pressurized gas into the mold, said gas charge being of pressure and quantity sufficient to enter into a contiguous portion (26) of the resin flow path contiguous to the portion of the article-defining cavity corresponding to the substantially planar portion (30), and not into the article-defining cavity;

maintaining the gas charge under pressure in the contiguous portion (26) during solidification of the plastic resin within the article-defining cavity; and

relieving the gas pressure within said contiguous portion (26) preparatory to removing said plastic article from the mold.

3. The method as described in claims 1 or 2 for the use of gas-assistance in the molding of a plastic article in an injection molding system, comprising the additional steps of:

injecting a second charge of pressurized gas into the mold at a location (23; 40) remote from the resin flow path (24, 26), said second

charge of gas being of a pressure and quantity sufficient to enter the article-defining cavity but not into the resin flow path (24, 26);

maintaining the first and second gas charges under pressure within the mold while the plastic resin solidifies within the article-defining cavity thereby completing the formation of the plastic article; and

relieving the gas pressure within the resin flow path (24, 26) and within the article-defining cavity.

4. The method as described in claims 1, 2 or 3, for injection molding of a plastic article (22) in an injection molding system including a mold having an injection aperture, an article-defining cavity and a resin reservoir (40) in communication with the cavity, the method comprising the steps of:

injecting an amount of molten plastic resin sufficient for the preparation of the plastic article through the injection aperture and along a first resin flow path (24, 26) which extends from the injection aperture to the article-defining cavity and along a second resin flow path which extends from the article-defining cavity to the resin reservoir (40);

injecting a first charge of pressurized gas into the mold, said first charge being of pressure and quantity sufficient to enter into the first resin flow path (24, 26), but not into the article-defining cavity;

injecting a second charge of pressurized gas into the resin reservoir (40), said second charge of gas being of pressure and quantity sufficient to enter the second resin flow path and thence into the article-defining cavity but not into the first resin flow path (24, 26);

maintaining the first and second gas charges under pressure in the mold during the solidification of the plastic resin within the article-defining cavity, thereby completing the formation of the plastic article; and

relieving the gas pressure within the first resin flow path (24, 26), and within the article-defining cavity preparatory to removing the plastic article (22) from the mold.

5. The method as described in claims 1, 2 or 3 for injection molding of a plastic article (22) in an injection molding system including a mold having an injection aperture, an article-defining cavity and a resin reservoir (40) in communication with the cavity, the method comprising the steps of:

injecting an amount of molten plastic resin sufficient for the preparation of the plastic article through the injection aperture and along a



first resin flow path (24, 26) which extends from the injection aperture to the article-defining cavity and along a second resin flow path which extends from the article-defining cavity to the resin reservoir (40);

injecting a first charge of pressurized gas into the mold, said first charge being of pressure and quantity sufficient to enter into the first resin flow path (24, 26), but not into the article-defining cavity;

injecting a second charge of pressurized gas into the resin reservoir (40), said second charge of gas being of pressure and quantity sufficient to enter the second resin flow path but not into the article-defining cavity;

maintaining the first and second gas charges under pressure in the mold during the solidification of the plastic resin within the article-defining cavity, thereby completing the formation of the plastic article; and

relieving the gas pressure within the first and second resin flow paths preparatory to removing the plastic article (22) from the mold.

6. The method as described in claim 1 or 3, wherein the step of relieving the resin flow path (24, 26) comprises separation of mold halves of the mold to cause self-rupture of the plastic resin containing the pressurized gas in the resin flow path (24, 26).
7. The method as described in claim 1 or 3, wherein the step of relieving the resin flow path includes the step of opening the resin flow path (24, 26) to permit ventilation of the gas contained therein.
8. The method as described in claim 2, wherein the step of relieving the molding includes separating mold halves of the mold to permit self-rupturing of the portion (26) of the resin flow path contiguous to the portion (30) of the article-defining cavity corresponding to the substantially planar portion.
9. The method as described in claim 2, wherein the step of relieving the molding includes the step of opening the resin flow path (26) contiguous to the portion of the article-defining cavity defining the substantially planar portion (30) to permit ventilation of the gas contained therein.
10. The method as described in claim 4 or 5, wherein the step of relieving the first resin flow path (24, 26) includes separating halves of the mold to permit self-rupturing of the plastic resin containing the pressurized gas in the first resin flow path portion (24, 26) of the article-

defining cavity.

11. The method as described in claim 4 or 5, wherein the step of relieving includes the step of opening the first resin flow path (24, 26) to permit ventilation of the gas contained therein.
12. The method as described in claim 1, 2, 3, 4 or 5, wherein the step of opening includes the step of piercing the plastic resin to form an aperture therein.
13. The method as described in claim 1, 2, 3, 4 or 5, wherein the step of opening includes the step of shearing the plastic resin to permit ventilation of the gas contained therein.
14. The method as claimed in claim 3, wherein the second charge of pressurized gas is injected directly into the article-defining cavity.

Patentansprüche

1. Verfahren zur Nutzung von Gasunterstützung beim Formgeben eines Kunststoffgegenstandes (22) mittels eines Spritzgießsystems mit einer Form, die eine Einspritzöffnung aufweist, mit den Schritten:
Einspritzen einer geschmolzenen Kunstharzmenge, die zum Herstellen des Kunststoffgegenstandes (22) ausreicht, durch die Einspritzöffnung entlang einem Harzfließweg (24, 26), der sich von der Einspritzöffnung zu einem den Gegenstand begrenzenden Formhohlraum erstreckt;
Einbringen einer Ladung eines unter Druck stehenden Gases durch den Harzfließweg (24, 26) in die Form und Aufrechterhalten des Drucks der Gasladung innerhalb der Form, während sich das Kunstharz innerhalb des den Gegenstand begrenzenden Formhohlraum verfestigt; und
Entlasten des Gasdrucks innerhalb des Fließweges, dadurch gekennzeichnet, daß das Verfahren den Schritt umfaßt, die Ladung des unter Druck stehenden Gases in die Form unter einem Druck und in einer Menge einzubringen, die ausreicht, um in den Harzfließweg einzudringen, nicht jedoch in den den Gegenstand begrenzenden Hohlraum.
2. Verfahren gemäß Anspruch 1 zum Spritzgießen eines Kunststoffgegenstandes (22), der wenigstens einen im wesentlichen ebenen Bereich (30) und der der Harzfließweg (24, 26) einen Bereich aufweist, der im wesentlichen zu dem Bereich des den Gegenstand begrenzenden Hohlraums benachbart ist, der dem im



wesentlichen ebenen Bereich (30) entspricht, mit den Schritten:

Einbringen einer Ladung eines unter Druck stehenden Gases in die Form mit einem Druck und in einer Menge, die ausreicht, um in einen benachbarten Bereich (26) des Harzfließweges einzudringen, der zu dem Bereich des den Gegenstand begrenzenden Hohlraums benachbart ist und dem im wesentlichen ebenen Bereich (30) entspricht, jedoch nicht in den den Gegenstand begrenzenden Hohlraum;

Aufrechterhalten des Drucks der Gasladung in dem benachbarten Bereich (26) während der Verfestigung des Kunstharzes in dem den Gegenstand begrenzenden Hohlraum; und

Entlasten des Gasdrucks innerhalb des benachbarten Bereichs (26) zur Vorbereitung des Entfernens des Kunststoffgegenstandes aus der Form.

3. Verfahren nach Anspruch 1 oder 2 zur Nutzung der Gasunterstützung bei der Formgebung eines Kunststoffgegenstandes mittels eines Spritzgießsystems mit den zusätzlichen Schritten:

Einbringen einer zweiten unter Druck stehenden Gasladung in die Form an einer Stelle (23; 40), die entfernt vom Harzfließweg (24, 26) gelegen ist, mit einem Druck und in einer Menge, die ausreicht, in den den Gegenstand begrenzenden Hohlraum einzudringen, jedoch nicht in den Harzfließweg (24, 26);

Aufrechterhalten des Drucks der ersten und der zweiten Gasladung innerhalb der Form während sich das Kunstharz in dem den Gegenstand begrenzenden Hohlraum verfestigt, wodurch die Formgebung des Kunststoffgegenstandes vollendet wird und

Entlasten des Gasdruckes in dem Harzfließ (24, 26) und in dem den Gegenstand begrenzenden Hohlraum.

4. Verfahren nach Anspruch 1, 2 oder 3 zum Spritzgießen eines Kunststoffgegenstandes (22) mittels eines Spritzgießsystems mit einer Form, die eine Einspritzöffnung, einen den Gegenstand begrenzenden Hohlraum und einen Harzaufnahmeraum (40) aufweist, der in Verbindung mit dem Hohlraum steht, mit den Schritten:

Einspritzen einer Menge geschmolzenen Kunstharzes, die für die Formgebung des Kunststoffgegenstandes ausreicht, durch die Einspritzöffnung und entlang einem ersten Harzfließweg (24, 26), der sich von der Einspritzöffnung zu dem den Gegenstand begrenzenden Hohlraum erstreckt und entlang einem zweiten Harzfließweg, der sich von dem den

Gegenstand begrenzenden Hohlraum zu dem Harzaufnahmeraum (40) erstreckt;

Einbringen einer ersten Ladung von unter Druck stehendem Gas in die Form mit einem Druck und in einer Menge, die ausreicht, um in den ersten Harzfließweg (24, 26) einzudringen, nicht jedoch in den den Gegenstand begrenzenden Hohlraum;

Einbringen einer zweiten Ladung eines unter Druck stehenden Gases in den Harzaufnahmeraum (44) mit einem Druck und in einer Menge, die ausreicht, um in den zweiten Harzfließweg und von dort in den den Gegenstand begrenzenden Hohlraum einzudringen, nicht jedoch in den ersten Harzfließweg (24, 26);

Aufrechterhalten des Drucks der ersten und zweiten Gasladung in der Form während sich das Kunstharz in dem den Gegenstand begrenzenden Hohlraum verfestigt, wodurch die Formgebung des Kunststoffgegenstandes vollendet wird und

Entlasten des Gasdrucks innerhalb des ersten Harzfließweges (24, 26) und innerhalb des den Gegenstand begrenzenden Hohlraums zur Vorbereitung des Entfernens des Kunststoffgegenstandes (22) aus der Form.

5. Verfahren nach Anspruch 1, 2 oder 3 zum Spritzgießen eines Kunststoffgegenstandes (22) mittels eines Spritzgießsystems mit einer Form, die eine Einspritzöffnung, einen den Gegenstand begrenzenden Hohlraum und einen Harzaufnahmeraum (40) aufweist, der mit dem Hohlraum in Verbindung steht, mit den Schritten:

Einspritzen einer Menge von geschmolzenem Kunstharz, die zur Herstellung des Kunststoffgegenstandes ausreicht, durch die Einspritzöffnung und entlang einem ersten Harzfließweg (24, 26), der sich von der Einspritzöffnung zum den Gegenstand begrenzenden Hohlraum erstreckt und entlang einem zweiten Harzfließweg, der sich von dem den Gegenstand begrenzenden Hohlraum zu dem Harzaufnahmeraum (40) erstreckt;

Einbringen einer ersten Ladung von unter Druck stehendem Gas in die Form mit einem Druck und in einer Menge, die ausreicht, um in den ersten Harzfließweg (24, 26) einzudringen, nicht jedoch in den den Gegenstand begrenzenden Hohlraum;

Einbringen einer zweiten Ladung von unter Druck stehendem Gas in den Harzaufnahmeraum (40) mit einem Druck und in einer Menge, die ausreicht, um in den zweiten Harzfließweg einzudringen, nicht aber in den den Gegenstand begrenzenden Hohlraum;

Aufrechterhalten des Drucks der ersten



und der zweiten Gasladung in der Form, während sich das Kunstharz in dem den Gegenstand begrenzenden Hohlraum verfestigt, wodurch die Formgebung des Kunststoffgegenstandes vollendet wird und

Entlasten des Gasdrucks innerhalb des ersten und zweiten Harzfließweges zur Vorbereitung des Entfernens des Kunststoffgegenstandes (22) aus der Form.

6. Verfahren nach Anspruch 1 oder 3, bei dem der Schritt des Druckentlastens des Harzfließweges (24, 26) das Auseinanderführen der Formhälften umfaßt, um das selbsttätige Platzen des Kunstharzes, das das unter Druck stehende Gas in dem Harzfließweg (24, 26) enthält, zu bewirken.

7. Verfahren nach Anspruch 1 oder 3, bei dem der Schritt der Druckentlastung des Harzfließweges den Schritt umfaßt, den Harzfließweg 24, 26 zu öffnen, um ein Abblasen des darin enthaltenen Gas zu bewirken.

8. Verfahren nach Anspruch 2, bei dem der Schritt der Druckentlastung des Formteils das selbsttätige Platzen der Formhälften der Form umfaßt, um das Zerreißen des Teils (26) des Harzfließweges zu bewirken, der zu dem Bereich (30) des den Gegenstand begrenzenden Hohlraums benachbart ist, der dem im wesentlichen ebenen Bereich entspricht.

9. Verfahren nach Anspruch 2, bei dem der Schritt des Druckentlastens des Formteils den Schritt umfaßt, den Harzfließweg (26) zu öffnen, der zu dem Bereich des den Gegenstand begrenzenden Hohlraums benachbart ist, der dem im wesentlichen ebenen Bereich entspricht, um ein Abblasen des darin enthaltenen Gases zu bewirken.

10. Verfahren nach Anspruch 4 oder 5, bei dem der Schritt des Druckentlastens des ersten Harzfließweges (24, 26) das Auseinanderführen von Hälften der Form umfaßt, um ein selbsttätiges Platzen des Kunstharzes, das das unter Druck stehende Gas im ersten Harzfließwegbereich (24, 26) des den Gegenstand begrenzenden Hohlraums enthält, zu bewirken.

11. Verfahren nach Anspruch 4 oder 5, bei dem der Schritt des Druckentlastens den Schritt des Öffnens des ersten Harzfließweges (24, 26) umfaßt, um ein Abblasen des darin enthaltenen Gases zu bewirken.

12. Verfahren nach Anspruch 1, 2, 4 oder 5, bei dem der Schritt des Öffnens das Durchstechen des Kunstharzes umfaßt, um darin eine Öffnung zu bilden.

13. Verfahren nach Anspruch 1, 2, 3 oder 5, bei dem der Schritt des Öffnens den Schritt des Abscherens des Kunstharzes umfaßt, um das Abblasen des darin enthaltenen Gases zu bewirken.

14. Verfahren nach Anspruch 3, bei dem die zweite Ladung von unter Druck stehendem Gas direkt in den den Gegenstand begrenzenden Hohlraum eingebracht wird.

Revendications

1. Procédé pour l'utilisation d'une assistance par gaz dans le moulage d'un objet en matière plastique (22) dans un système de moulage par injection comprenant un moule ayant un orifice d'injection, le procédé comportant les étapes consistant à :

injecter une quantité suffisante de résine plastique fondue pour la préparation de l'objet en matière plastique (22) par l'orifice d'injection et le long d'une voie d'écoulement de résine (24, 26) s'étendant de l'orifice d'injection à un creux définissant l'objet dans le moule :

injecter une charge gazeuse sous pression le long de ladite voie d'écoulement de résine (24, 26) et jusque dans le moule, en maintenant la charge gazeuse sous pression dans le moule pendant que la résine plastique se solidifie dans le creux définissant l'objet ; et à décharger la pression gazeuse dans ladite voie d'écoulement ;

caractérisé en ce que ledit procédé comporte l'étape consistant à injecter ladite charge gazeuse sous pression dans le moule à une pression et en quantité suffisantes pour pénétrer la voie d'écoulement de la résine mais non le creux qui définit l'objet.

2. Procédé selon la revendication 1 pour le moulage par injection d'un objet en matière plastique (22) ayant au moins une partie (30) sensiblement plane, ladite voie d'écoulement de la résine (24, 26) comportant une partie qui est sensiblement contiguë à une partie du creux définissant l'objet correspondant à la partie (30) sensiblement plane, le procédé comportant des étapes consistant à :

injecter une charge gazeuse sous pression dans le moule, la pression et la quantité de ladite charge gazeuse étant suffisantes pour que celle-ci pénètre une partie contiguë (26)



de la voie d'écoulement de résine qui est contiguë à la partie du creux définissant le moule correspondant à la partie sensiblement plane, mais non le creux qui définit l'objet ;

maintenir la charge gazeuse sous pression dans la partie contiguë (26) pendant la solidification de la résine plastique à l'intérieur du creux définissant l'objet ; et à

décharger la pression gazeuse dans ladite partie contiguë (26) avant de retirer ledit objet en matière plastique du moule.

3. Procédé selon la revendication 1 ou la revendication 2 pour l'utilisation d'une assistance par gaz dans le moulage d'un objet en matière plastique dans un système de moulage par injection comportant les étapes supplémentaires consistant à :

injecter une deuxième charge gazeuse sous pression dans le moule à un emplacement (23 ; 40) éloigné de la voie d'écoulement de la résine (24, 26), la pression et la quantité de ladite deuxième charge gazeuse étant suffisantes pour que celle-ci pénètre le creux définissant l'objet mais non la voie d'écoulement de la résine (24, 26) ;

maintenir les première et deuxième charges gazeuses sous pression à l'intérieur du moule pendant que la résine plastique se solidifie à l'intérieur du creux définissant l'objet, terminant ainsi la formation de l'objet en matière plastique ; et à

décharger la pression gazeuse dans la voie d'écoulement de la résine (24, 26) et dans le creux définissant l'objet.

4. Procédé selon les revendications 1, 2 ou 3, pour le moulage par injection d'un objet en matière plastique (22) dans un système de moulage par injection comprenant un moule muni d'un orifice d'injection, d'un creux définissant un objet et d'un réservoir à résine (40) qui communique avec le creux, le procédé comportant les étapes consistant à :

injecter une quantité suffisante de résine plastique fondue pour la préparation de l'objet en matière plastique (22) par l'orifice d'injection et le long d'une première voie d'écoulement de résine (24, 26) s'étendant de l'orifice d'injection à un creux définissant l'objet, et le long d'une deuxième voie d'écoulement de la résine qui s'étend du creux définissant l'objet jusqu'au réservoir à résine (40) ;

injecter une première charge gazeuse sous pression dans le moule, la pression et la quantité de ladite première charge gazeuse étant suffisantes pour que celle-ci pénètre la première voie d'écoulement de la résine (24, 26) mais

non le creux définissant l'objet ;

injecter une deuxième charge gazeuse sous pression dans le réservoir à résine (40), la pression et la quantité de ladite deuxième charge gazeuse étant suffisantes pour que celle-ci pénètre la deuxième voie d'écoulement de la résine puis le creux définissant l'objet, mais non la première voie d'écoulement de la résine (24, 26) ;

maintenir les première et deuxième charges gazeuses sous pression dans le moule pendant que la résine plastique se solidifie dans le creux définissant l'objet, terminant ainsi la formation de l'objet en matière plastique ; et à décharger la pression gazeuse dans la première voie d'écoulement de la résine (24, 26) et dans le creux définissant l'objet avant de retirer l'objet en matière plastique (22) du moule.

5. Procédé selon les revendications 1, 2 ou 3, pour le moulage par injection d'un objet en matière plastique (22) dans un système de moulage par injection comprenant un moule muni d'un orifice d'injection, d'un creux définissant un objet et d'un réservoir à résine (40) qui communique avec le creux, le procédé comportant les étapes consistant à :

injecter une quantité suffisante de résine plastique fondue pour la préparation de l'objet en matière plastique (22) par l'orifice d'injection et le long d'une première voie d'écoulement de résine (24, 26) s'étendant de l'orifice d'injection au creux définissant l'objet, et le long d'une deuxième voie d'écoulement de la résine qui s'étend du creux définissant l'objet jusqu'au réservoir à résine (40) ;

injecter une première charge gazeuse sous pression dans le moule, la pression et la quantité de ladite première charge gazeuse étant suffisantes pour que celle-ci pénètre la première voie d'écoulement de la résine (24, 26) mais non le creux définissant l'objet ;

injecter une deuxième charge gazeuse sous pression dans le réservoir à résine (40), la pression et la quantité de ladite deuxième charge gazeuse étant suffisantes pour que celle-ci pénètre la deuxième voie d'écoulement de la résine, mais non le creux définissant l'objet ;

maintenir les première et deuxième charges gazeuses sous pression dans le moule pendant que la résine plastique se solidifie dans le creux définissant l'objet, terminant ainsi la formation de l'objet en matière plastique ; et à décharger la pression gazeuse dans les première et deuxième voies d'écoulement de la résine avant de retirer l'objet en matière plastique (22) du moule.



6. Procédé selon la revendication 1 ou la revendication 3, caractérisé en ce que l'étape de déchargement de la voie d'écoulement de la résine (24, 26) comprend la séparation de demi-moules du moule pour provoquer une rupture automatique de la résine plastique contenant le gaz sous pression dans la voie d'écoulement de la résine (24, 26). 5
7. Procédé selon la revendication 1 ou la revendication 3, caractérisé en ce que l'étape de déchargement de la voie d'écoulement de la résine comprend l'étape d'ouverture de la voie d'écoulement de la résine (24, 26) pour permettre de vider le gaz contenu dans celle-ci. 10
15
8. Procédé selon la revendication 2, caractérisé en ce que l'étape de déchargement du moulage comprend la séparation de demi-moules de moule pour permettre une rupture automatique de la partie (26) de la voie d'écoulement de la résine contigue à la partie (30) du creux définissant l'objet et correspondant à la partie sensiblement plane. 20
25
9. Procédé selon la revendication 2, caractérisé en ce que l'étape de déchargement du moulage comprend l'étape consistant à ouvrir la voie d'écoulement de la résine (26) contigue à la partie du creux délimitant la partie (30) sensiblement plane pour permettre de vider le gaz contenu dans celle-ci. 30
10. Procédé selon la revendication 4 ou la revendication 5, caractérisé en ce que l'étape de déchargement de la première voie d'écoulement de la résine (24, 26) comprend la séparation de moitiés du moule pour permettre une rupture automatique de la résine plastique contenant le gaz sous pression dans la première partie de voie d'écoulement de la résine (24, 26) du creux définissant l'objet. 35
40
11. Procédé selon la revendication 4 ou la revendication 5, caractérisé en ce que l'étape de déchargement comprend l'étape consistant à ouvrir la première voie d'écoulement de la résine (24, 26) pour permettre de vider le gaz contenu dans celle-ci. 45
50
12. Procédé selon la revendication 1, 2, 3, 4 ou 5, caractérisé en ce que l'étape d'ouverture comprend l'étape consistant à percer la résine plastique pour y former un orifice. 55
13. Procédé selon la revendication 1, 2, 3, 4 ou 5, caractérisé en ce que l'étape d'ouverture comprend l'étape consistant à cisailer la résine 11

plastique pour permettre de vider le gaz contenu dans celle-ci.

14. Procédé selon la revendication 3, caractérisé en ce que la deuxième charge gazeuse sous pression est injectée directement dans le creux définissant l'objet.