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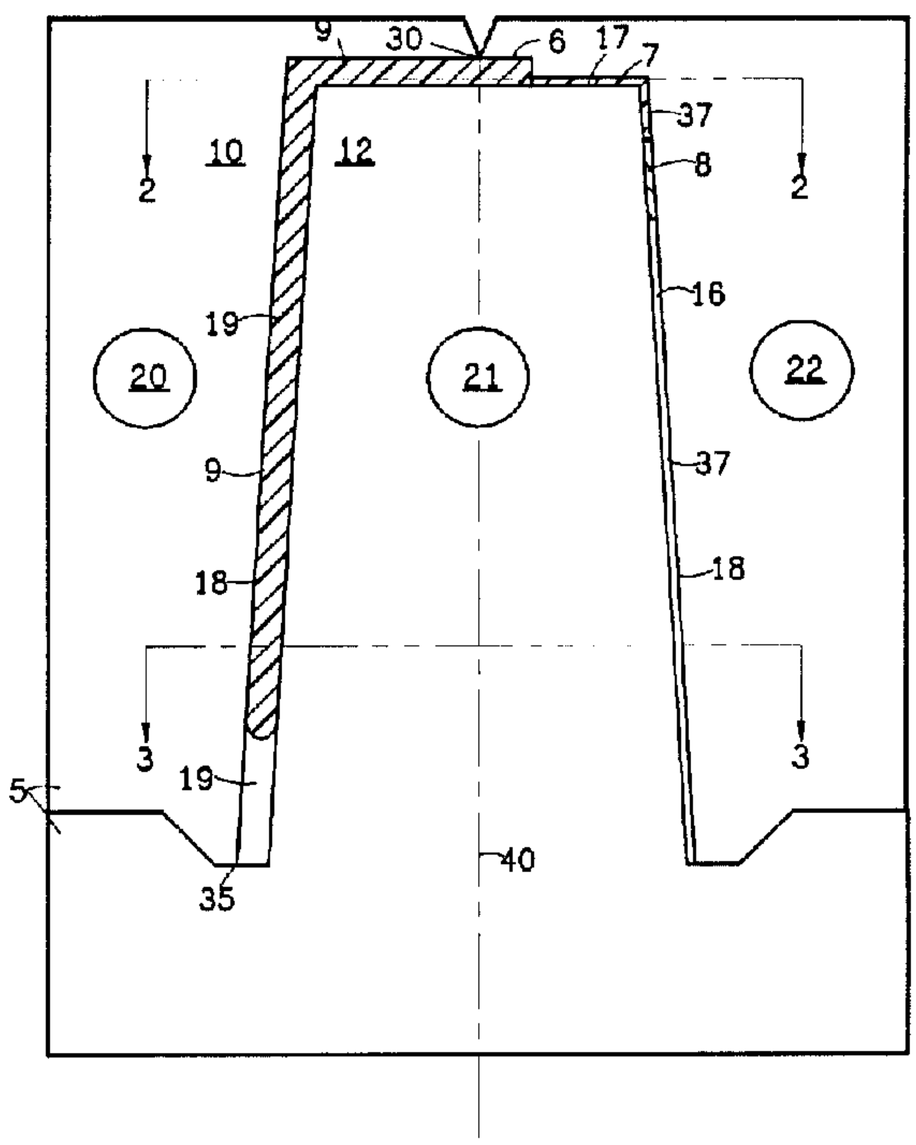
(54) **CONTROLE DES DIMENSIONS D'ARTICLES MOULES PAR INJECTION ET REDUCTION DE LA FORCE DE FERMETURE**

(54) **INJECTION-MOLDING DIMENSION-CONTROL AND CLAMP-REDUCTION**




(57) Les dimensions d'un produit en plastique creux moulé par injection sont commandées et la force de séparation exercée contre les sections du moule (10, 12) lors du moulage du produit sont réduites en injectant un matériau plastique de manière continue depuis une porte (30) dans une cavité (16) d'un moule ayant des canaux d'écoulement (19) s'étendant au travers de la région de la cavité jusqu'à ce que la cavité du moule soit remplie de ce matériau en plastique injecté, ladite injection s'effectuant dans des conditions de pression d'injection, de température de la matière plastique injectée, de la température de la cavité du moule, de la longueur du canal d'écoulement, de la distance entre les canaux d'écoulement, de l'épaisseur des canaux d'écoulement et

(57) The dimensions of an injected molded hollow plastic product are controlled and the separative force exerted against mold sections (10, 12) during molding of the product are reduced by injecting plastic material continuously from a gate (30) into a mold cavity (16) having flow channels (19), extending through the cavity region until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature, mold cavity temperature, flow channel length, distance between flow channels, flow channel thickness and wall thickness in a thin-cavity region between flow channels that initially injected plastic material solidifies in the thin-cavity regions to thereby

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de l'épaisseur de la paroi des canaux d'écoulement dans une région de cavité mince entre des canaux d'écoulement telles que la matière plastique injectée initialement se solidifie dans les régions de cavité mince de manière à stabiliser une section de moule par rapport à l'autre section de moule avant que la cavité du moule ne soit remplie de matière plastique injectée et de manière à réduire ladite force de séparation.

stabilize one mold section being filled with the injected plastic material, and to thereby reduce said separative force.

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(57) Abstract

The dimensions of an injected molded hollow plastic product are controlled and the separative force exerted against mold sections (10, 12) during molding of the product are reduced by injecting plastic material continuously from a gate (30) into a mold cavity (16) having flow channels (19), extending through the cavity region until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature, mold cavity temperature, flow channel length, distance between flow channels, flow channel thickness and wall thickness in a thin-cavity region between flow channels that initially injected plastic material solidifies in the thin-cavity regions to thereby stabilize one mold section being filled with the injected plastic material, and to thereby reduce said separative force.

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# INJECTION-MOLDING DIMENSION-CONTROL AND CLAMP-REDUCTION

## Background of the Invention

The present invention generally pertains to injection molding of plastic products and is particularly directed to improvement in methods of controlling the wall thickness of a plastic product while being injection molded and improvement in methods of reducing the clamping force requirements of a plastic product while being injection molded.

Prior art methods for controlling the wall thickness of a plastic product while being injection molded and for reducing the clamping force requirements of a plastic product while being injection molded are described in U.S. Patent No. 3,375,554 to Blumer, U.S. Patent No. 3,737,272 to Segmuller, U.S. Patent No. 3,995,007 to Spiegelberg, U.S. Patent No. 4,264,295 to Hingley and U.S. Patents Nos. 4,381,275; 4,467,994; 4,508,676 and 4,789,326 all to Sorensen.

## Summary of the Invention

This invention seeks to provide a method of controlling the dimensions of a hollow plastic product injection molded within the cavity of a mold having a core section and a cavity section defining the mold cavity therebetween and separated by a parting line, comprising stabilizing the core section in relation to the cavity section and comprising the steps of: (a) injecting a first plastic material into the mold cavity so that only a part of the mold cavity is filled; (b) cooling the injected first plastic material in the mold cavity; (c) injecting subsequent to injecting the first plastic material, a second plastic material into the mold cavity so that the cooled injected first plastic material extending between the core section and the cavity section in said part of the mold cavity is sufficiently

solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material, whereby the injected second plastic material fills the mold cavity; and (d) cooling the injected plastic material in the mold cavity to thereby solidify the product; the method being characterized by the following additional steps, step (a) comprising the step of: (e) continuing the injection of the first plastic material by the second plastic material without intermission; step (b) comprising the step of: (f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid; step (c) comprising the step of: (g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to fill the mold cavity and so that some of the at least partially solidified first plastic material stabilizes the core section in relation to the cavity section.

The invention further seeks to provide a method of reducing the clamping force required to produce a plastic product injection molded within the cavity of a mold having a first mold section and a second mold section defining the mold cavity therebetween and separated by a parting line comprising: (a) injecting a first plastic material into the mold cavity so that only a part of the mold cavity is filled; (b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section; (c) injecting a second plastic material under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material so that the cooled

injected first plastic material in said section of the mold cavity impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure whereby the injected second plastic material fills the mold cavity; and (d) cooling the injected plastic material in the mold cavity to thereby solidify the product; the method being characterized by the following additional steps: step (a) comprising the step of: (e) continuing the injection of the first plastic material by the second plastic material without intermission; step (b) comprising the step of: (f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid; step (c) comprising the step of: (g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to fill the mold cavity and so that some of the at least partially solidified first plastic material impedes transmission of injection pressure causing separative forces of the first mold section in relation to the second mold section.

The invention further seeks to provide a method of controlling dimensions of a hollow plastic product having perimetric side walls that is injection molded by using a core mold section and a cavity mold section that are combined to define a mold cavity for the product therebetween and which mold sections, when so combined, are separated by a parting line, wherein the mold cavity includes a gate in a base region and flow channels extending from the base region through a region of the cavity that defines the side walls of the product, the method comprising the step of injecting plastic

material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature, mold cavity wall temperature, flow channel length, distance between flow channels, flow channel thickness and wall thickness in a thin-cavity region between flow channels that initially injected plastic material solidifies in the thin-cavity regions to stabilize the core mold section in relation to the cavity mold section prior to the mold cavity being filled with the injected plastic material.

The invention further seeks to provide a method of controlling dimensions of a hollow plastic product having perimetric side walls that is injection molded by using a core mold section and a cavity mold section that are combined to define a mold cavity for the product therebetween, and which mold sections, when so combined, are separated by a parting line, wherein the mold cavity includes a gate in a base region and flow channels extending from the base region through a region of the cavity that defines the side walls of the product, the method comprising the steps of: (a) forming said mold cavity in which within a portion of the mold cavity, the quotient of a ratio of flow channel length to distance between flow channels divided by the square of a ratio of flow channel thickness to wall thickness in a thin-cavity region between flow channels is less than two; and (b) injecting plastic material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature and mold cavity wall temperature that initially injected plastic material solidifies in the thin-cavity regions to stabilize the core mold section in relation to the cavity mold section prior to

the mold cavity being filled with the injected plastic material.

The invention further seeks to provide a method of reducing a separative force exerted against mold sections when injection molding a hollow plastic product that is injected by using a first mold section and a second mold section that are combined to define a mold cavity for the product therebetween, and which mold sections, when so combined, are separated by a parting line, wherein the mold cavity includes a gate and flow channels extending through a region of the cavity, wherein plastic material injected into the mold cavity exerts said separative force against the mold sections while said injected plastic remains in a fluid state, the method comprising the step of: injecting plastic material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature, mold cavity wall temperature, flow channel length, distance between flow channels, flow channel thickness and wall thickness in a thin-cavity region between flow channels that initially injected plastic material solidifies in the thin-cavity regions prior to the mold cavity being filled with the injected plastic material to thereby reduce said separative force.

The invention further seeks to provide a method of reducing a separative force exerted against mold sections when injection molding a hollow plastic product that is injected by using a first mold section and a second mold section that are combined to define a mold cavity for the product therebetween, and which mold sections when so combined are separated by a parting line, wherein the mold cavity includes a gate and flow channels extending through a region of the cavity, wherein plastic material injected into the mold cavity exerts said

separative force against the mold sections while said injected plastic remains in a fluid state the method comprising the steps of: (a) forming said mold cavity in which within a portion of the mold cavity, the quotient of a ratio of flow channel length to distance between flow channels divided by the square of a ratio of flow channel thickness to wall thickness in a thin-cavity region between flow channels is less than two; and (b) injecting plastic material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure injected plastic material temperature and mold cavity wall temperature that initially injected plastic material solidifies in the thin-cavity regions prior to the mold cavity being filled with the injected plastic material to thereby reduce said separative force.

The invention further seeks to provide a method of controlling the dimensions of a hollow plastic product having laminated walls injection molded within a cavity of a mold having a core section and a cavity section defining the mold cavity therebetween, comprising stabilizing the core section in relation to the cavity section and providing in advance an early layer of the laminated plastic product encased in the mold cavity and further comprising the steps of: (a) injecting a first plastic material into the mold cavity which encases the early layer so that only a region of the early layer is coated by the injected first plastic material; (b) cooling the injected first plastic material in the mold cavity; (c) injecting subsequent to injecting the first plastic material, a second plastic material into the mold cavity so that the cooled injected first plastic material extending between the early layer and either the core section or the cavity section in combination with the early layer of said region are sufficiently solidified to stabilize the core section in

relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material, whereby the injected second plastic material further fills the mold cavity, thereby further coating the early layer; and (d) cooling the injected plastic material in the mold cavity to thereby solidify the laminated product; wherein step (a) comprises the step of: (e) continuing the injection of the first plastic material by the second plastic material without intermission.

The invention further seeks to provide a method of reducing the clamping force required to produce a plastic product having laminated walls injection molded within a cavity of a mold having a first mold section and a second mold section defining the cooling cavity therebetween, comprising providing in advance an early layer of the laminated plastic product encased in the mold cavity and further comprising the steps of: (a) injecting a first plastic material into the mold cavity which encases the early layer so that only a region of the early layer is coated by the injected first plastic material; (b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section; (c) injecting a second plastic material under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material, so that the cooled injected first plastic material in combination with the early layer of said region impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure, whereby the injected second plastic material further fills the mold cavity, thereby further

coating the early layer; and (d) cooling the injected plastic material in the mold cavity to thereby solidify the product wherein step (a) comprises the step of: (e) continuing the injection of the first plastic material by the second plastic material without intermission.

The invention further seeks to provide a method of controlling the dimensions of a hollow plastic product having laminated walls injection molded in a cavity of a mold having a core section and a cavity section defining the mold cavity therebetween, comprising stabilizing the core section in relation to the cavity section and comprising the steps of: (a) injecting a first plastic material into the mold cavity; (b) cooling the injected first plastic material in the mold cavity; (c) injecting subsequent to injecting the first plastic material, a second plastic material into the mold cavity so that the cooled injected first plastic material extending between the core section and the cavity section is sufficiently solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material, whereby the injected second plastic material further fills the mold cavity; (d) cooling the injected plastic material in the mold cavity to thereby provide an early layer of the laminated plastic product; and (e) encasing the early layer in a second mold cavity and injecting additional plastic material into the second mold cavity thereby coating the early layer with the additional plastic material to mold the laminated plastic product; wherein step (a) comprises the step of: (f) continuing the injection of the first plastic material by the second plastic material without intermission.

The invention further seeks to provide a method of reducing the clamping force required to produce a plastic product having laminated walls injection molded in a cavity of

a mold having a first mold section and a second mold section defining the cooling cavity therebetween comprising: (a) injecting a first plastic material into the mold cavity; (b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section; (c) injecting a second plastic under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material, so that the cooled injected first plastic material impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure whereby the injected second plastic material further fills the mold cavity; (d) cooling the injected plastic material in the mold cavity to thereby provide an early layer of the laminated product; and (e) encasing the early layer in a second mold cavity and injecting additional plastic material into the second mold cavity thereby coating the early layer with the additional plastic material to mold the laminated plastic product; wherein step (a) comprises the step of: (f) continuing the injection of the first plastic material by the second plastic material without intermission.

The invention further seeks to provide a method of controlling the dimensions of a hollow plastic product injection molded within a cavity of a mold having a core section and a cavity section defining the mold cavity therebetween comprising the steps of: (a) injecting a first plastic material into the mold cavity; (b) cooling the injected first plastic material in the mold cavity; (c) injecting subsequent to injecting the first plastic material a second plastic material into the mold cavity so that the cooled

injected first plastic material is sufficiently solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material whereby the injected second plastic material further fills the mold cavity; and (d) cooling the injected plastic material in the mold cavity to thereby solidify the molded product; wherein step (a) comprises the step of: (e) continuing the injection of the first plastic material by the second plastic material without intermission.

The invention further seeks to provide a method of reducing the clamping force required to produce a plastic product injection molded within a cavity of a mold having a first mold section and a second mold section defining the cooling cavity therebetween, comprising the steps of: (a) injecting a first plastic material into the mold cavity; (b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section; (c) injecting a second plastic material under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material so that the cooled injected first plastic material impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure, whereby the injected second plastic material further fills the mold cavity; and (d) cooling the injected plastic material in the mold cavity to thereby solidify the product; wherein step (a) comprises the step of: (e) continuing the injection of the first plastic material by the second plastic material without

intermission.

Additional features of the present invention are described in relation to the description of the preferred embodiments.

**Brief Description of the Drawing**

Figure 1 is a sectional view of a mold used to execute one preferred embodiment of the method of the present invention.

Figure 2 is a sectional view of the mold shown in Figure 1 taken along lines 2-2.

Figure 3 is a sectional view of the mold shown in Figure 1 taken along lines 3-3.

The sectional view of Figure 1 is taken along lines A-A of Figure 2 and along lines B-B of Figure 3.

Figure 4 is a sectional view of a mold used to execute a preferred embodiment of the method of the present invention for molding a hollow plastic product with laminated walls.

Figure 5 is a sectional view of the mold shown in Figure 4 taken along lines 5-5.

Figure 6 is a sectional view of the mold shown in Figure 4 taken along lines 6-6.

The sectional view of Figure 4 is taken along lines C-C of Figure 5 and along lines D-D of Figure 6.

The product wall thickness shown in the Drawing are increased in order to better show the invention. The actual wall thicknesses are normally much smaller, and depend on the type of plastic material, the temperature of the plastic material, the mold temperature, the thermal conductivity of the mold wall material, the flow distances, the injection pressure, and other molding parameters.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figures 1, 2 and 3, the preferred embodiment of the invention utilizes a mold 5 with a cavity mold section 10 and a core mold section 12, shown in its assembled arrangement. The mold 5 defines a mold cavity 16 for forming a plastic product having perimetric side walls, not shown in its fully molded outline. The mold cavity 16 includes a base region 17, a side-wall-defining region 18 and flow channels 19 extending from the base region 17 through the side-wall-defining region 18.

Cooling means 20, 21 and 22 are used to cool both the first and second injected plastic material. Molten plastic material may be injected into the mold cavity 16 via a gate 30 located in the center of the base region 17 of the mold cavity 16. The cavity section 10 and the core section 12 are separated by a parting line 35. The mold cavity 16 may be opened along axis 40 for ejection of a molded product.

The methods of the preferred embodiment are executed as follows. A first plastic material 6, 7, 8, 9 is injected into the mold cavity 16 so that only a part of the mold cavity 16 is filled, a second plastic material is injected without intermission. The first plastic material has the same chemical composition as the second plastic material.

A portion of the first plastic material 7 cools in the thin cavity region 37 between flow channels 19 before the second plastic material is injected so that it is at least partially solidified and so that another portion of the first plastic material 6, 8, 9 remains fluid.

The at least partially solidified portion of the first plastic cools very fast before a second plastic material is injected, because the wall thickness of the thin-cavity region 37 is very thin. Another portion of the first plastic material 6, 8, 9 remains fluid because the wall thickness of the flow channels 19 is relatively thick.

Subsequent to injecting the first plastic material 6, 7, 8, 9, a second plastic material is injected into the mold cavity via the gate 30. The second plastic material displaces some of the fluid first plastic material in the flow channels 19, and thereby induces a number of flow paths 9 for the second plastic to fill the mold cavity 16.

Some of the at least partially solidified first plastic material 7 in the thin cavity regions 37 is sufficiently solidified to stabilize and support the core section 12 in relation to the cavity section 10 by impeding movement caused by injecting the second plastic material.

Some of the at least partially solidified first plastic material 7 in the thin cavity regions 37 is also sufficiently solidified to impede transmission of injection pressure in the first plastic material 7, caused by injecting the second plastic material which effect separative forces of the core mold section 12 in relation to the cavity mold section 10. The injected plastic material is then cooled to completely solidify the product.

The first plastic material is injected so that is does not completely cover the parting line 35 and fill the mold cavity 16, and the second plastic material is injected so that it completely covers the parting line and fills the mold cavity 16.

An example is as follows, the thin product wall thickness in the thin cavity regions 37 being 0.15 mm, the thick product wall thickness of the flow channels 19 being 0.6mm, the plastic material being polypropylene or polystyrene at a temperature of 300 degrees C, the mold temperature being 10 degrees C, the thermal conductivity of the mold being that of steel, the flow distance through the

side-wall defining region 18 of the flow channels 19 being about 150mm, the distance between flow channels 19 being about 5 mm, and the injection pressure being 2000 Bar.

Referring to Figures 4, 5 and 6, the preferred embodiment of the invention used when molding a hollow plastic product with laminated walls utilizes a mold 45 with a cavity mold section 50 and a core mold section 12, shown in its assembled arrangement. The mold 45 defines a mold cavity 56 for forming a plastic product having laminated perimetric side walls, not shown in its fully molded outline. An early layer 52 of the laminated plastic product is encased on the core section 12 in the mold cavity 56. The early layer 52 was formed in accordance with the embodiment of the invention described with reference to Figures 1, 2 and 3.

The mold cavity 56 includes a base region 57, a side-wall-defining region 58 and flow channels 59 extending from the base region 57 through the side-wall-defining region 58.

Cooling means 20', 21 and 22' are used to cool both the first and second injected plastic material. Molten plastic material may be injected into the mold cavity 56 via a gate 70 located in the center of the base region 57 of the mold cavity 56. The cavity section 50 and the core section 12 are separated by a parting line 75. The mold cavity 56 may be opened along axis 40 for ejection of a molded product.

The methods of this preferred embodiment are executed as follows. A first plastic material 46, 47, 48, 49 is injected into the mold cavity 56 so that only a part of the mold cavity 56 is filled, a second plastic material is injected without intermission. The first plastic material has the same chemical composition as the second plastic material. Only a region of the early layer 52 is coated with the first plastic material 46, 47, 48, 49, as shown in Figure 4.

A portion of the first plastic material 47 cools in the thin cavity region 77 between flow channels 59 before the second plastic material is injected so that it is at least partially solidified and so that another portion of the first plastic material 46, 48, 49 remains fluid.

The at least partially solidified portion of the first plastic cools very fast before a second plastic material is injected, because the wall thickness of the thin-cavity region 77 is very thin. Another portion of the first plastic material 46, 48, 49 remains fluid because the wall thickness of the flow channels 59 is relatively thick.

Subsequent to injecting the first plastic material 46, 47, 48, 49, a second plastic material is injected into the mold cavity via the gate 70. The second plastic material displaces some of the fluid first plastic material in the flow channels 59, and thereby induces a number of flow paths 49 for the second plastic to fill the mold cavity 56, and further coat the early layer 52.

Some of the at least partially solidified first plastic material 47 in the thin cavity regions 77 is sufficiently solidified to combine with a sufficiently solidified portion of the early layer 52 to stabilize and support the core section 12 in relation to the cavity section 50 by impeding movement caused by injecting the second plastic material.

Some of the at least partially solidified first plastic material 47 in the thin cavity regions 77 is also sufficiently solidified to combine with a sufficiently solidified portion of the early layer 52 to impede transmission of injection pressure in the first plastic material 47, caused by injecting the second plastic material which effect separative forces of the core mold section 12 in relation to the cavity mold section 50. The injected plastic material is then cooled to completely solidify the product.

The first plastic material is injected so that is does not completely cover the parting line 75 and fill the mold cavity 56, and the second plastic material is injected so that it completely covers the parting line and fills the mold cavity 56.

In the particular preferred embodiments of the invention described herein, contrary to certain prior art methods of core steering, no retractable portion of the core section and/or the cavity section is protracted to contact the other mold section to stabilize the core section in relation to the cavity section during the continuous injection of the plastic material; the configuration of the mold cavity as defined by the mold sections is maintained without change during the continuous injection of plastic material; the mold cavity is formed by combining mold sections that define a mold cavity that does not include any throttle between the base region and the side wall defining region; and no use is made of multiple gates, in order to create one or more flow path for the second plastic material to fill the mold cavity.

In other preferred embodiments of the present invention the first plastic material is injected into the mold cavity via more than one gate and the second plastic material is injected into the mold cavity via the same gates.

When the method of the invention is used only for reducing the required clamping force for the product and not for steering the core section, the method of the invention may be executed in molds which do not have a core section and a cavity section.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of controlling the dimensions of a hollow plastic product injection molded within the cavity of a mold having a core section and a cavity section defining the mold cavity therebetween and separated by a parting line, comprising stabilizing the core section in relation to the cavity section and comprising the steps of:

(a) injecting a first plastic material into the mold cavity so that only a part of the mold cavity is filled;

(b) cooling the injected first plastic material in the mold cavity;

(c) injecting subsequent to injecting the first plastic material, a second plastic material into the mold cavity so that the cooled injected first plastic material extending between the core section and the cavity section in said part of the mold cavity is sufficiently solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material, whereby the injected second plastic material fills the mold cavity; and

(d) cooling the injected plastic material in the mold cavity to thereby solidify the product;

the method being characterized by the following additional steps,

step (a) comprising the step of:

(e) continuing the injection of the first plastic material by the second plastic material without intermission;

step (b) comprising the step of:

(f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid;

step (c) comprising the step of:

(g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to fill the mold cavity and so that some of the at least partially solidified first plastic material stabilizes the core section in relation to the cavity section.

2. A method according to claim 1, wherein no retractable portion of the core section and/or the cavity section is withdrawn in order to create at least one flow path for the second plastic material to fill the mold cavity.

3. A method according to claim 1, wherein step (a) comprises the step of:

(h) injecting the first plastic material so that the injected first plastic material does not completely cover the parting line; and wherein step (c) comprises the step of:

(i) injecting the second plastic material so that the injected second plastic material fills the mold cavity to



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thereby completely cover the parting line.

4. A method according to claim 1 wherein step (f) comprises the steps of:

(h) cooling said portion of the first plastic material so that it is at least partially solidified by molding said portion in a relatively thin wall thickness;

(i) cooling a portion of the first plastic material so that another portion of the first plastic material remains fluid by molding said portion in a relatively thick wall thickness.

5. A method according to claim 1 wherein the first plastic material has the same chemical composition as the second plastic material.

6. A method according to claim 1 wherein the first plastic material is injected into the mold cavity via at least one gate and wherein the second plastic material is injected into the mold cavity via the same at least one gate.

7. A method according to claim 1 wherein no use is made of multiple gates in order to create at least one flow path for the second plastic material to fill the mold cavity.

8. A method according to claim 1 wherein no use is made of temporary cavity-section-to-free-end-of-core-section



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contact during the molding cycle.

9. A method according to claim 1 wherein no use is made of any of throttles valves and reduced throats between the core section and the cavity section of the mold cavity.

10. A method according to claim 1 for controlling the dimensions of an injection molded hollow plastic product having laminated walls wherein the mold cavity contains a previously injected plastic product when first and second plastic material is injected so that one said wall includes the previously injected plastic product.

11. A method of reducing the clamping force required to produce a plastic product injection molded within the cavity of a mold having a first mold section and a second mold section defining the mold cavity therebetween and separated by a parting line comprising:

(a) injecting a first plastic material into the mold cavity so that only a part of the mold cavity is filled;

(b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section;

(c) injecting a second plastic material under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material so that the cooled injected first

plastic material in said section of the mold cavity impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure whereby the injected second plastic material fills the mold cavity; and

(d) cooling the injected plastic material in the mold cavity to thereby solidify the product;

the method being characterized by the following additional steps:

step (a) comprising the step of:

(e) continuing the injection of the first plastic material by the second plastic material without intermission;

step (b) comprising the step of:

(f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid;

step (c) comprising the step of:

(g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to fill the mold cavity and so that some of the at least partially solidified first plastic material impedes transmission of injection pressure causing separative forces of the first mold section in relation to the second mold section.

12. A method according to claim 11 wherein no retractable portion of the first mold section and/or the second mold section is withdrawn in order to create at least one flow path for the second plastic material to fill the mold cavity.

13. A method according to claim 11 wherein step (a) comprises the step of:

(h) injecting the first plastic material so that the injected first plastic material does not completely cover the parting line; and wherein step (c) comprises the step of:

(i) injecting the second plastic material so that the injected second plastic material fills the mold cavity to thereby completely cover the parting line.

14. A method according to claim 11 wherein step (f) comprises the steps of:

(h) cooling said portion of the first plastic material so that it is at least partially solidified by molding said portion in a relatively thin wall thickness;

(i) cooling a portion of the first plastic material so that another portion of the first plastic material remains fluid by molding said portion in a relatively thick wall thickness.

15. A method according to claim 11 wherein the first plastic material has the same chemical composition as the second plastic material.

16. A method according to claim 11 wherein the first plastic material is injected into the mold cavity via at least one gate and wherein the second plastic material is injected into the mold cavity via the same at least one gate.

17. A method according to claim 11 wherein no use is made of multiple gates in order to create at least one flow path for the second plastic material to fill the mold cavity.

18. A method according to claim 11 wherein no use is made of temporary cavity-section-to-free-end-of-core-section contact during the molding cycle.

19. A method according to claim 11, wherein no use is made of any of throttles, valves and reduced throats between the first mold section and the second mold section of the mold cavity.

20. A method according to claim 1 for reducing the clamping force required when injection molding a hollow plastic product having laminated walls, wherein the mold cavity contains a previously injected plastic product when first and second plastic material is injected so that one said wall includes the previously injected plastic product.

21. A method of controlling dimensions of a hollow plastic product having perimetric side walls that is injection



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molded by using a core mold section and a cavity mold section that are combined to define a mold cavity for the product therebetween and which mold sections, when so combined, are separated by a parting line, wherein the mold cavity includes a gate in a base region and flow channels extending from the base region through a region of the cavity that defines the side walls of the product, the method comprising the step of injecting plastic material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature, mold cavity wall temperature, flow channel length, distance between flow channels, flow channel thickness and wall thickness in a thin-cavity region between flow channels that initially injected plastic material solidifies in the thin-cavity regions to stabilize the core mold section in relation to the cavity mold section prior to the mold cavity being filled with the injected plastic material.

22. A method according to claim 21, comprising the step of forming said mold cavity by combining said mold sections that define a cavity that does not include any throttle between the base region and the sidewall defining region.

23. A method according to claim 21, comprising the step of maintaining the mold cavity, as defined by the mold sections, without change in configuration during said



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continuous injection of plastic material.

24. A method according to claim 21, comprising the step of forming said mold cavity by combining said mold sections that do not contact each other within said mold cavity to stabilize the core mold section in relation to the cavity mold section during said continuous injection of plastic material.

25. A method according to claim 21, comprising the step of forming said mold cavity with a plastic material portion that previously was injected onto one of said one mold sections being included in said mold cavity.

26. A method of controlling dimensions of a hollow plastic product having perimetric side walls that is injection molded by using a core mold section and a cavity mold section that are combined to define a mold cavity for the product therebetween, and which mold sections, when so combined, are separated by a parting line, wherein the mold cavity includes a gate in a base region and flow channels extending from the base region through a region of the cavity that defines the side walls of the product, the method comprising the steps of:

(a) forming said mold cavity in which within a portion of the mold cavity, the quotient of a ratio of flow channel length to distance between flow channels divided by the square of a ratio of flow channel thickness to wall thickness in a thin-cavity region between flow channels is less than two; and

(b) injecting plastic material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature and mold cavity wall temperature that initially injected plastic material solidifies in the thin-cavity regions to stabilize the core mold section in relation to the cavity mold section prior to the mold cavity being filled with the injected plastic material.

27. A method according to claim 26, comprising the step of:

(c) forming said mold cavity by combining said mold sections that define a cavity that does not include any throttle between the base region and the side wall defining region.

28. A method according to claim 26, comprising the step of:

(c) forming said mold cavity by combining said mold sections that do not contact each other within said mold cavity to stabilize the core mold section in relation to the cavity mold section during said continuous injection of plastic material.

29. A method of reducing a separative force exerted against mold sections when injection molding a hollow plastic

product that is injected by using a first mold section and a second mold section that are combined to define a mold cavity for the product therebetween, and which mold sections, when so combined, are separated by a parting line, wherein the mold cavity includes a gate and flow channels extending through a region of the cavity, wherein plastic material injected into the mold cavity exerts said separative force against the mold sections while said injected plastic remains in a fluid state, the method comprising the step of:

injecting plastic material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure, injected plastic material temperature, mold cavity wall temperature, flow channel length, distance between flow channels, flow channel thickness and wall thickness in a thin-cavity region between flow channels that initially injected plastic material solidifies in the thin-cavity regions prior to the mold cavity being filled with the injected plastic material to thereby reduce said separative force.

30. A method according to claim 29, comprising the step of maintaining the mold cavity, as defined by the mold sections, without change in configuration during said continuous injection of plastic material.

31. A method according to claim 29, comprising the step of forming said mold cavity with a plastic material portion that previously was injected onto one of said one mold sections being included in said mold cavity.

32. A method of reducing a separative force exerted against mold sections when injection molding a hollow plastic product that is injected by using a first mold section and a second mold section that are combined to define a mold cavity for the product therebetween, and which mold sections when so combined are separated by a parting line, wherein the mold cavity includes a gate and flow channels extending through a region of the cavity, wherein plastic material injected into the mold cavity exerts said separative force against the mold sections while said injected plastic remains in a fluid state the method comprising the steps of:

(a) forming said mold cavity in which within a portion of the mold cavity, the quotient of a ratio of flow channel length to distance between flow channels divided by the square of a ratio of flow channel thickness to wall thickness in a thin-cavity region between flow channels is less than two; and

(b) injecting plastic material continuously into the mold cavity from the gate until the mold cavity is filled with said injected plastic material, with said injection being under such conditions of injection pressure injected plastic material temperature and mold cavity wall temperature that initially injected plastic material solidifies in the thin-

cavity regions prior to the mold cavity being filled with the injected plastic material to thereby reduce said separative force.

33. A method of controlling the dimensions of a hollow plastic product having laminated walls injection molded within a cavity of a mold having a core section and a cavity section defining the mold cavity therebetween, comprising stabilizing the core section in relation to the cavity section and providing in advance an early layer of the laminated plastic product encased in the mold cavity and further comprising the steps of:

(a) injecting a first plastic material into the mold cavity which encases the early layer so that only a region of the early layer is coated by the injected first plastic material;

(b) cooling the injected first plastic material in the mold cavity;

(c) injecting subsequent to injecting the first plastic material, a second plastic material into the mold cavity so that the cooled injected first plastic material extending between the early layer and either the core section or the cavity section in combination with the early layer of said region are sufficiently solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material, whereby the injected

second plastic material further fills the mold cavity, thereby further coating the early layer; and

(d) cooling the injected plastic material in the mold cavity to thereby solidify the laminated product; wherein step (a) comprises the step of:

(e) continuing the injection of the first plastic material by the second plastic material without intermission.

34. A method according to claim 33, wherein step (b) comprises the step of:

(f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid, and wherein step (c) comprises the step of:

(g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to further fill the mold cavity and so that the cooled injected first plastic material in combination with the early layer of said region are sufficiently solidified to stabilize the core section in relation to the cavity section.

35. A method of reducing the clamping force required to produce a plastic product having laminated walls injection molded within a cavity of a mold having a first mold section and a second mold section defining the cooling cavity there-



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between, comprising providing in advance an early layer of the laminated plastic product encased in the mold cavity and further comprising the steps of:

(a) injecting a first plastic material into the mold cavity which encases the early layer so that only a region of the early layer is coated by the injected first plastic material;

(b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section;

(c) injecting a second plastic material under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material, so that the cooled injected first plastic material in combination with the early layer of said region impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure, whereby the injected second plastic material further fills the mold cavity, thereby further coating the early layer; and

(d) cooling the injected plastic material in the mold cavity to thereby solidify the product wherein step (a) comprises the step of:

(e) continuing the injection of the first plastic material by the second plastic material without intermission.

36. A method according to claim 35, wherein step (b) comprises the step of:

(f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid; and wherein step (c) comprises the step of:

(g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to further fill the mold cavity, and so that the cooled injected first plastic material in combination with the early layer of said region impedes transmission of injection pressure causing separative forces of the first mold section in relation to the second mold section.

37. A method of controlling the dimensions of a hollow plastic product having laminated walls injection molded in a cavity of a mold having a core section and a cavity section defining the mold cavity therebetween, comprising stabilizing the core section in relation to the cavity section and comprising the steps of:

(a) injecting a first plastic material into the mold cavity;

(b) cooling the injected first plastic material in the mold cavity;

(c) injecting subsequent to injecting the first plastic

material, a second plastic material into the mold cavity so that the cooled injected first plastic material extending between the core section and the cavity section is sufficiently solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material, whereby the injected second plastic material further fills the mold cavity;

(d) cooling the injected plastic material in the mold cavity to thereby provide an early layer of the laminated plastic product; and

(e) encasing the early layer in a second mold cavity and injecting additional plastic material into the second mold cavity thereby coating the early layer with the additional plastic material to mold the laminated plastic product;

wherein step (a) comprises the step of:

(f) continuing the injection of the first plastic material by the second plastic material without intermission.

38. A method according to claim 37, wherein step (b) comprises the step of:

(g) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid; and

wherein step (c) comprises the step of:

(h) injecting the second plastic material so that the second plastic material displaces some of the fluid first



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plastic material to thereby provide at least one flow path for the second plastic material to fill the mold cavity, and so that some of the at least partially solidified first plastic material stabilizes the core section in relation to the cavity section.

39. A method according to claim 37, wherein step (e) comprises the steps of:

(g) injecting a first portion of the additional plastic material into the second mold cavity which encases the early layer so that only a region of the early layer is coated by the injected first portion of the additional plastic material;

(h) cooling the injected first portion of the additional plastic material in the mold cavity;

(i) injecting subsequent to injecting the first portion of the additional plastic material, a second portion of the additional plastic material into the second mold cavity so that the cooled injected first portion of the additional plastic material extending between the early layer and either the core section or the cavity section in combination with the early layer of said region are sufficiently solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second portion of the additional plastic material, whereby the injected second portion of the additional plastic material further fills the second mold cavity, thereby further coating the early layer.

40. A method of reducing the clamping force required to produce a plastic product having laminated walls injection molded in a cavity of a mold having a first mold section and a second mold section defining the cooling cavity therebetween comprising:

(a) injecting a first plastic material into the mold cavity;

(b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section;

(c) injecting a second plastic under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material, so that the cooled injected first plastic material impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure whereby the injected second plastic material further fills the mold cavity;

(d) cooling the injected plastic material in the mold cavity to thereby provide an early layer of the laminated product; and

(e) encasing the early layer in a second mold cavity and injecting additional plastic material into the second mold cavity thereby coating the early layer with the additional

plastic material to mold the laminated plastic product;

wherein step (a) comprises the step of:

(f) continuing the injection of the first plastic material by the second plastic material without intermission.

41. A method according to claim 40, wherein step (b) comprises the step of:

(g) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid; and

wherein step (c) comprises the step of:

(h) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to fill the mold cavity and so that some of the at least partially solidified first plastic material impedes transmission of injection pressure causing separative forces of the first mold section in relation to the second mold section.

42. A method according to claim 40, wherein step (e) comprises the steps of:

(g) injecting a first portion of the additional plastic material into the second mold cavity which encases the early layer so that only a region of the early layer is coated by the injected first portion of the additional plastic material;

(h) cooling the injected first portion of the additional

plastic material in the second mold cavity to solidify a portion of the first portion of the additional plastic material in a section of the second mold cavity extending between the first mold section and the second mold section;

(i) injecting a second portion of the additional plastic material under pressure into the second mold cavity subsequent to solidifying said portion of the first portion of the additional plastic material so that the cooled injected first portion of the additional plastic material in combination with the early layer of said region impedes transmission of injection pressure caused by injecting the second portion of the additional plastic material to thereby reduce during injection of the second portion of the additional plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure whereby the injected second portion of the additional plastic material further fills the second mold cavity, thereby further coating the early layer.

43. A method of controlling the dimensions of a hollow plastic product injection molded within a cavity of a mold having a core section and a cavity section defining the mold cavity therebetween comprising the steps of:

(a) injecting a first plastic material into the mold cavity;

(b) cooling the injected first plastic material in the mold cavity;

(c) injecting subsequent to injecting the first plastic material a second plastic material into the mold cavity so that the cooled injected first plastic material is sufficiently solidified to stabilize the core section in relation to the cavity section by impeding movement of the core section in relation to the cavity section caused by injecting the second plastic material whereby the injected second plastic material further fills the mold cavity; and

(d) cooling the injected plastic material in the mold cavity to thereby solidify the molded product; wherein step (a) comprises the step of:

(e) continuing the injection of the first plastic material by the second plastic material without intermission.

44. A method according to claim 43 wherein step (b) comprises the step of:

(f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid; and wherein step (c) comprises the step of:

(g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to further fill the mold cavity and so that the cooled injected first plastic material is sufficiently solidified to stabilize the core section in relation to the cavity section.



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45. A method of reducing the clamping force required to produce a plastic product injection molded within a cavity of a mold having a first mold section and a second mold section defining the cooling cavity therebetween, comprising the steps of:

(a) injecting a first plastic material into the mold cavity;

(b) cooling the injected first plastic material in the mold cavity to solidify a portion of the first plastic material in a section of the mold cavity extending between the first mold section and the second mold section;

(c) injecting a second plastic material under pressure into the mold cavity subsequent to solidifying said portion of the first plastic material so that the cooled injected first plastic material impedes transmission of injection pressure caused by injecting the second plastic material to thereby reduce during injection of the second plastic material the clamping force required to overcome forces that tend to separate the first and second mold sections as a result of injection pressure, whereby the injected second plastic material further fills the mold cavity; and

(d) cooling the injected plastic material in the mold cavity to thereby solidify the product; wherein step (a) comprises the step of:

(e) continuing the injection of the first plastic material by the second plastic material without intermission.

46. A method according to claim 45, wherein step (b) comprises the step of:

(f) cooling a portion of the first plastic material so that it is at least partially solidified and so that another portion of the first plastic material remains fluid; and

wherein step (c) comprises the step of:

(g) injecting the second plastic material so that the second plastic material displaces some of the fluid first plastic material to thereby provide at least one flow path for the second plastic material to further fill the mold cavity, and so that the cooled injected first plastic material impedes transmission of injection pressure causing separative forces of the first mold section in relation to the second mold section.

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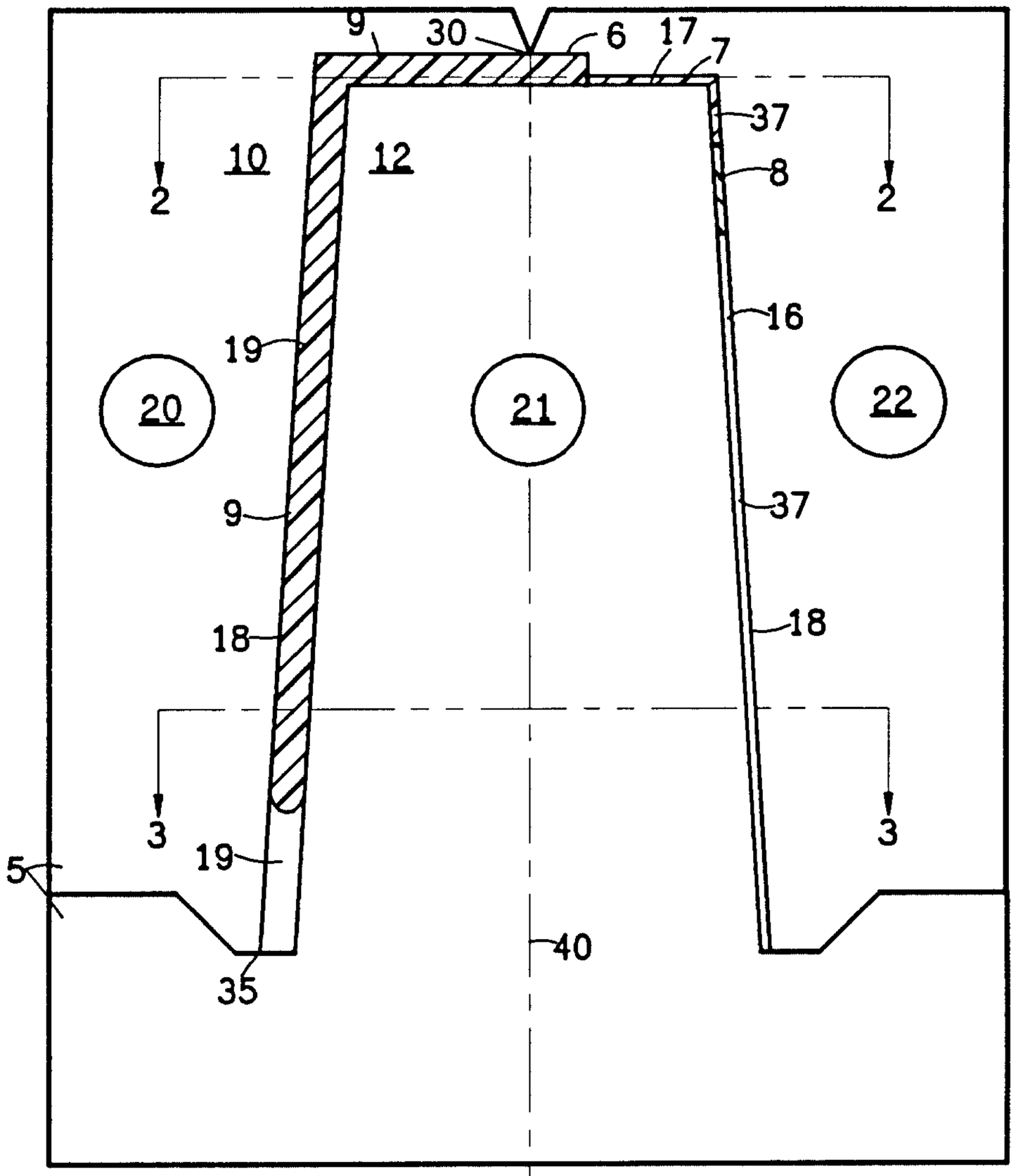


FIG. 1

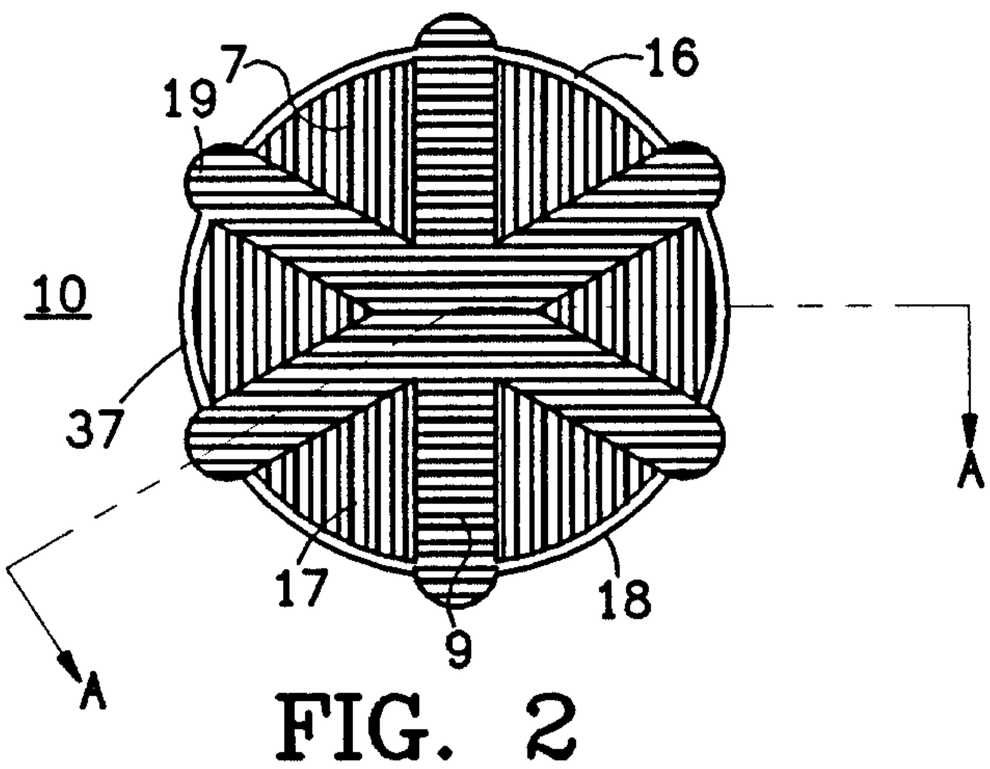


FIG. 2

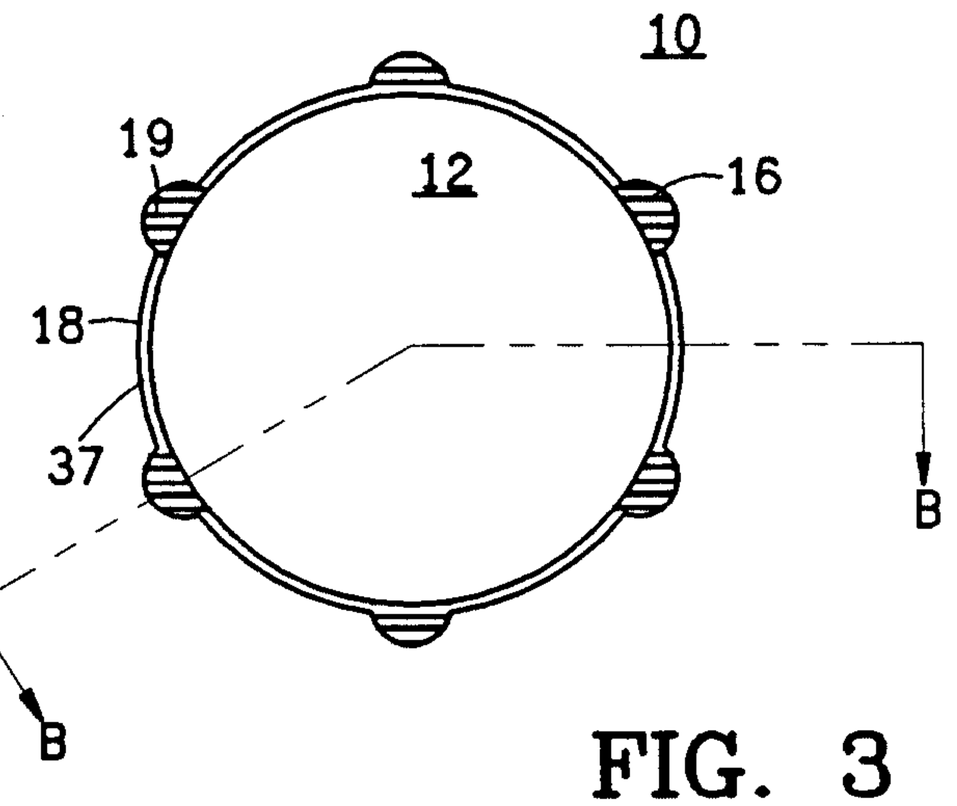


FIG. 3

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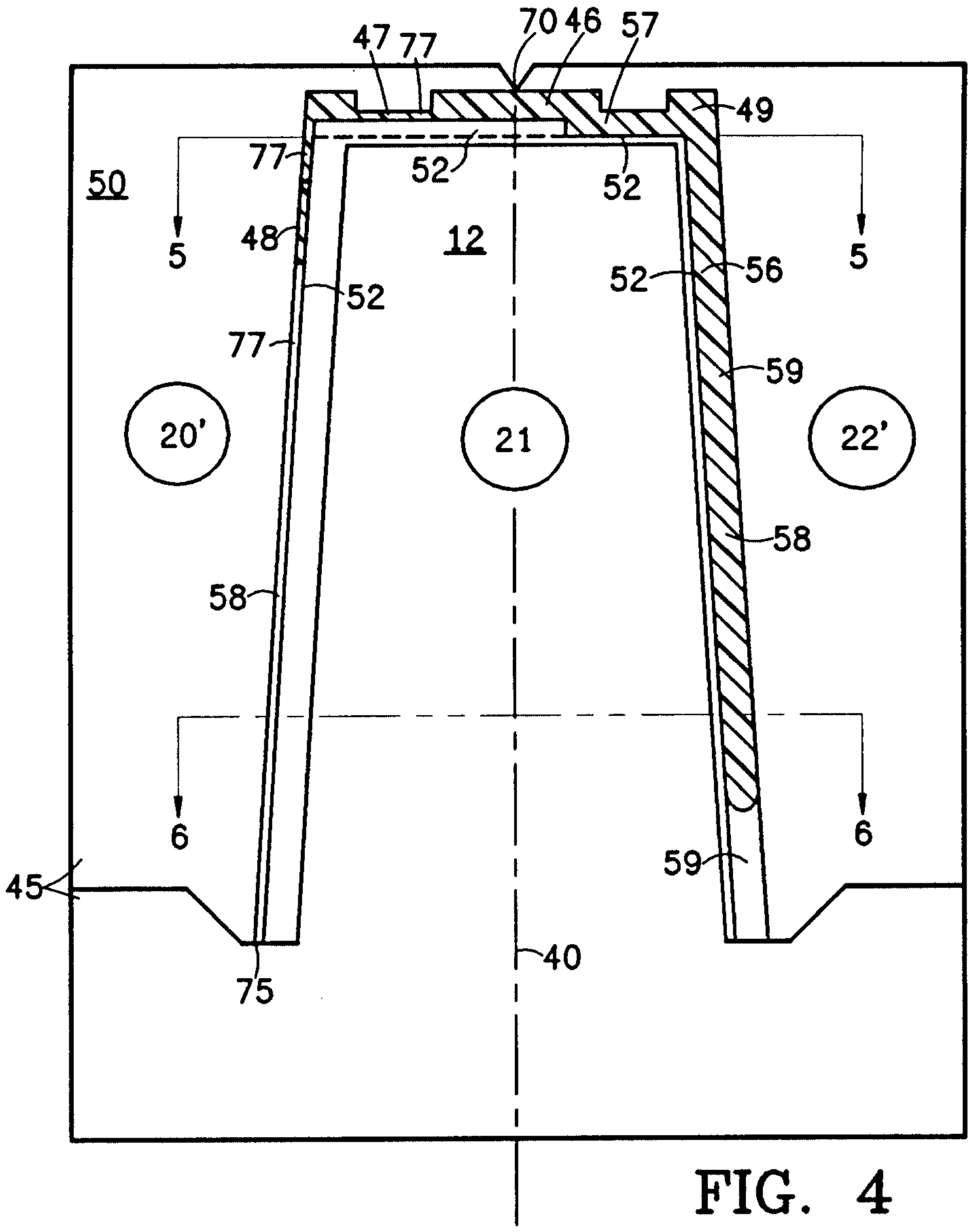


FIG. 4

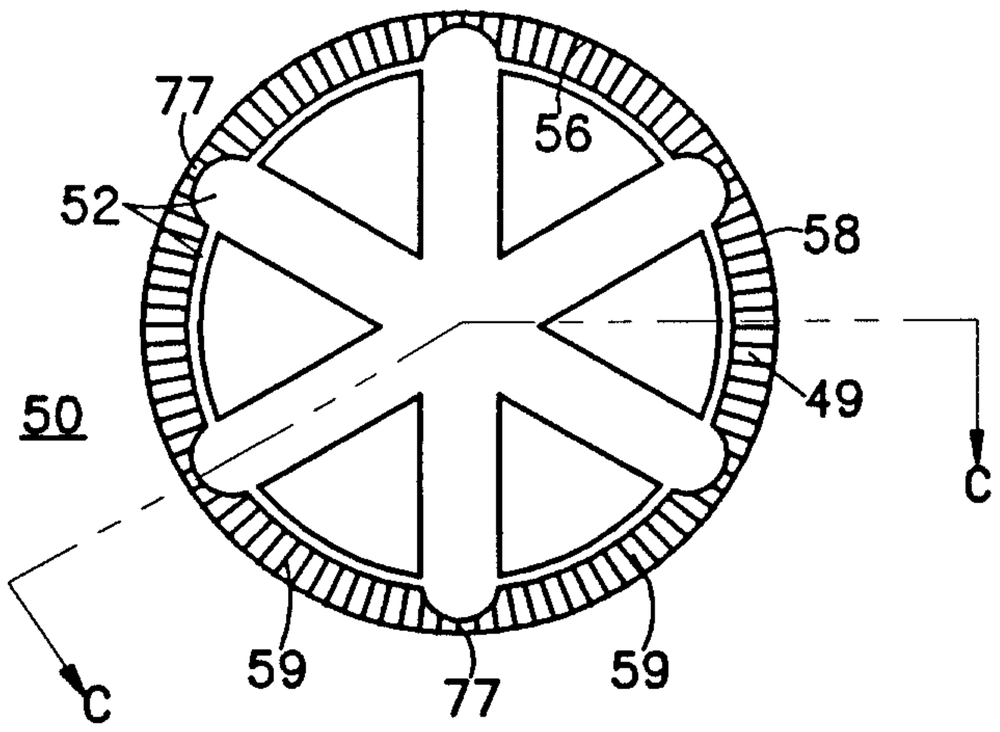


FIG. 5

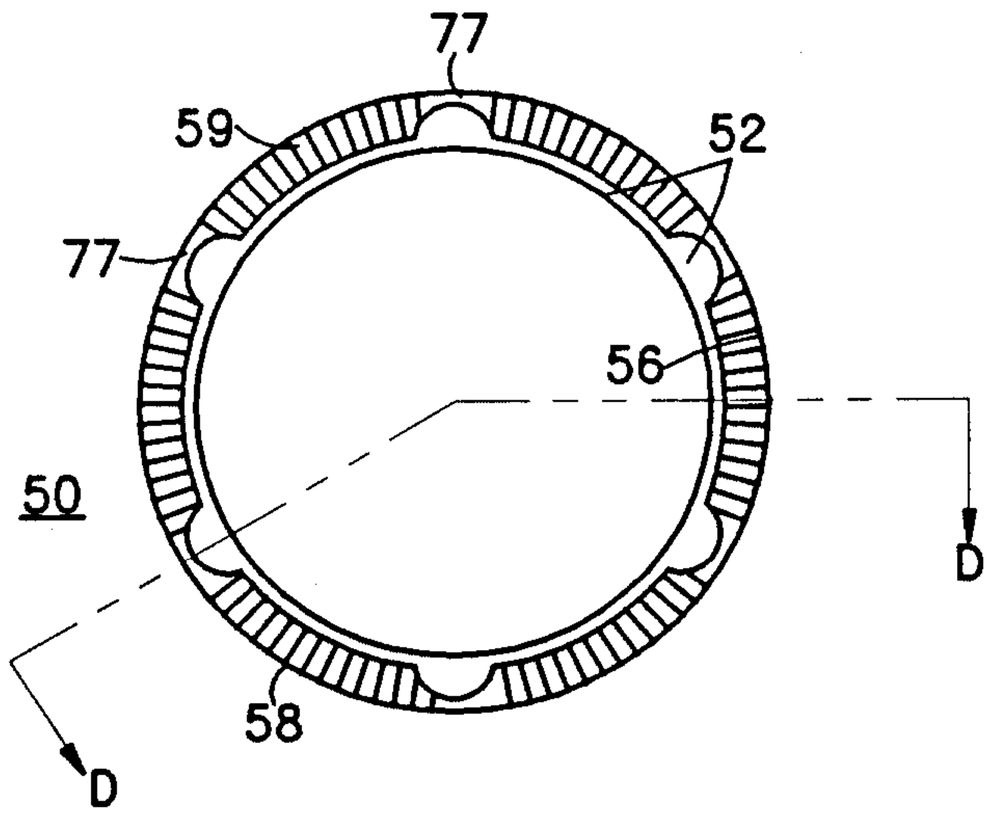


FIG. 6

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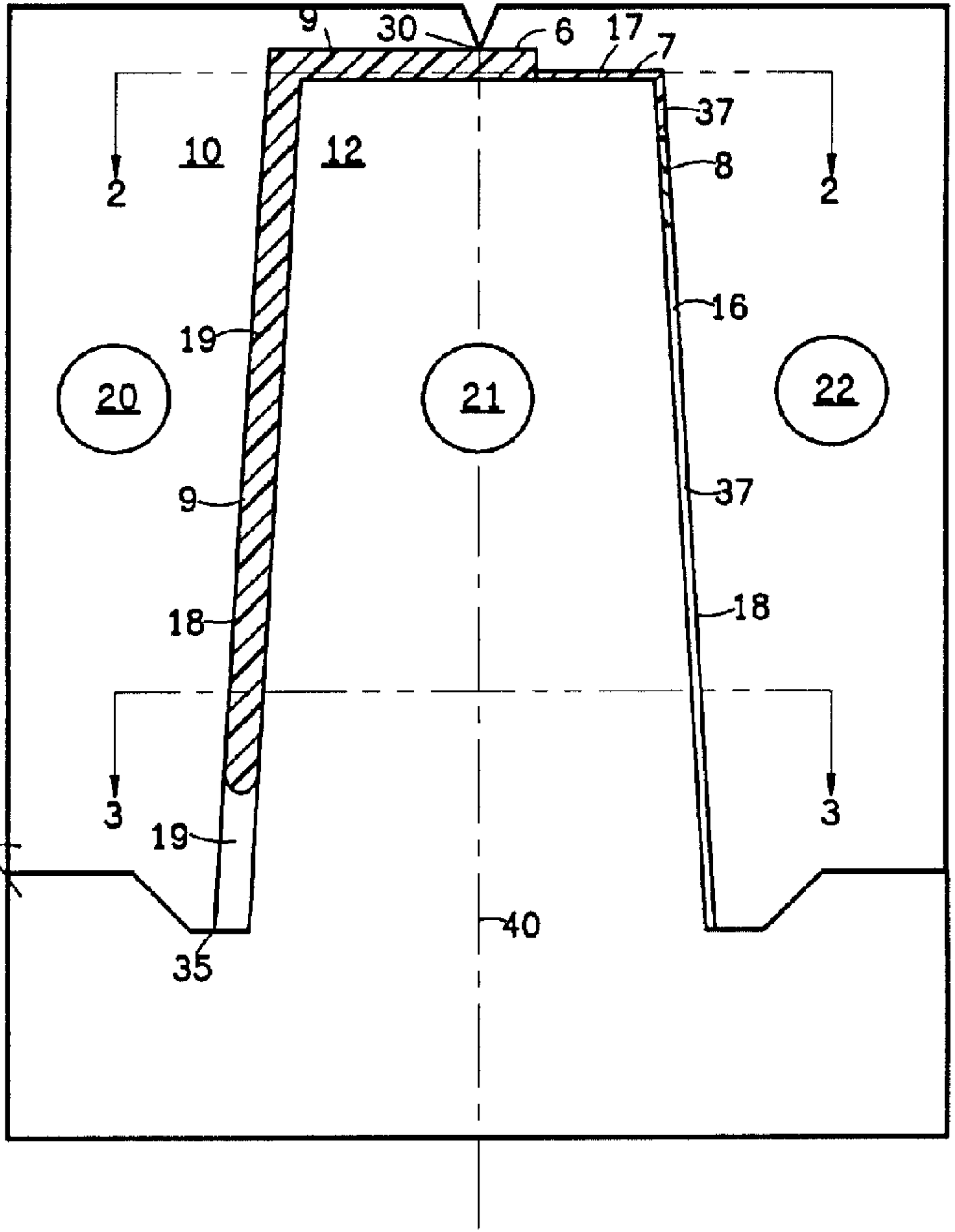
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