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(71) Applicant: **HUSKY INJECTION MOLDING SYSTEMS LTD.** [CA/CA]; 500 QUEEN STREET SOUTH, BOLTON, Ontario L7E 5S5 (CA).

(72) Inventor: **RASCHE, Sebastian**; Am Mariahof 40, 54296 Trier (DE).

(74) Agent: **GOW, Geoffrey**; C/O HUSKY INJECTION MOLDING SYSTEMS LTD., 500 QUEEN STREET SOUTH, BOLTON, Ontario L7E 5S5 (CA).

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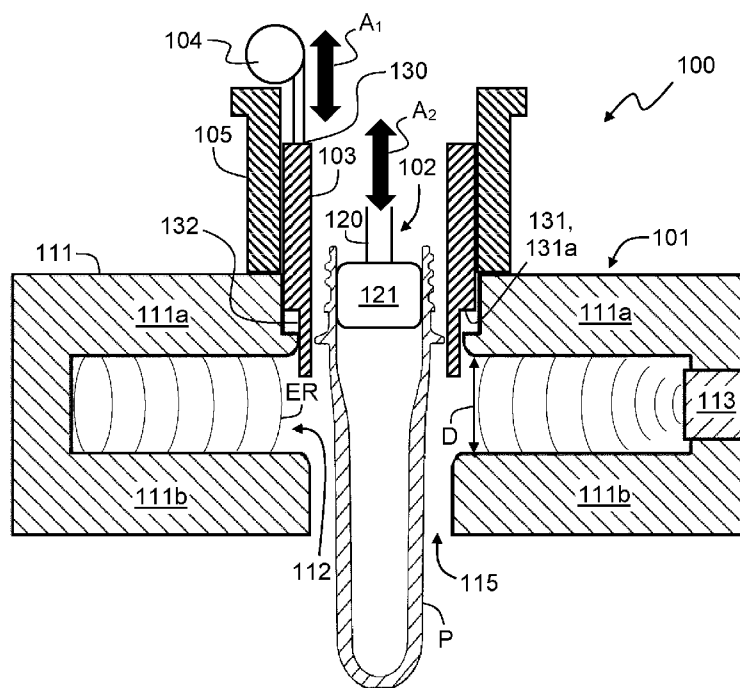


FIGURE 1

(57) Abstract: The invention relates to a preform conditioning system (100, 200, 300), which includes a heating device (101, 201, 301), a preform holder (102, 202, 302) for holding a preform (P) to be irradiated by electromagnetic radiation (ER) from the heating device and a screen (103, 203, 303) shaped and configured to at least partially surround a preform (P) held by the preform holder (102, 202, 302) for selectively screening part of the preform (P) from electromagnetic radiation (ER). The position of the screen (103, 203, 303) is adjustable relative to each of the heating device (101, 201, 301) and a preform (P) held by the preform holder (102, 202, 302).

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LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE,
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CONDITIONING SYSTEM

FIELD OF THE INVENTION

5 This invention relates generally to conditioning systems and molding systems that include such conditioning systems. More specifically, although not exclusively, this invention relates to conditioning systems for tubular articles, such as preforms, and to molding systems in which such tubular articles are heated by the conditioning system prior to blow molding, and to associated methods.

10

BACKGROUND OF THE INVENTION

Molding is a process by virtue of which a molded article can be formed from molding material, such as a plastics material, by using a molding system, such as an injection molding system or a compression molding system. Various molded articles can be formed by using such molding processes including, for example, tubular articles such as preforms which can be formed from polyethylene terephthalate (PET) material. Such preforms are capable of being subsequently blown into a container, for example a beverage container, bottle, can or the like, using a blow molding process.

20 Preforms for beverage containers require a so-called "neck region", which includes engaging features for cooperation with a closure assembly for closing the beverage container, and may also include handling features for handling the preforms before, during and after blowing. Typically and as an example, the neck region includes (i) engaging features, such as threads (or other suitable structure), for accepting and retaining a closure assembly (e.g. a bottle cap) and (ii) anti-pilferage features for cooperating with the closure assembly to indicate whether the end product (e.g. the beverage container that has been filled with a beverage and shipped to a store) has been tampered with in any way. The neck region may comprise other additional elements used for various purposes, such as to cooperate with parts of the molding system (e.g. a support ledge, etc).

30 In order to shape the preforms during the blow molding process, the body of the preform is heated and stretched in a heated state, whilst minimising any distortion of the neck region. This requirement limits the ability to heat the portion of the body immediately below the neck region, to avoid distortion of the neck region.

In an effort to mitigate this issue, it is known, for example from EP2439047 and US3830893, to provide a shield surrounding the threads of the preform.

5 **SUMMARY OF THE INVENTION**

The present invention seeks to provide an improved conditioning system. In particular but not exclusively, this invention seeks to provide a conditioning system that is more versatile.

10 This invention is directed, in particular but not exclusively, to a conditioning system for conditioning tubular articles such as preforms.

A broad aspect of the invention provides a conditioning system. The conditioning system may, but need not, comprise a conditioning device, e.g. for conditioning an article. The conditioning system
15 may, but need not, comprise a holder, e.g. for holding an article to be conditioned. The conditioning system may, but need not, comprise a screen. The screen may, but need not, be shaped and/or configured to at least partially surround an article held, in use, by the holder, e.g. for selectively screening part of the article from conditioning means. The position of the screen may, but need not, be adjustable relative to at least one or each of the holder, or an article held by the holder, and the
20 conditioning device.

Another broad aspect of the invention provides a conditioning system comprising a conditioning device for conditioning an article, a holder for holding an article to be conditioned and a screen shaped and configured to at least partially surround an article held, in use, by the holder for selectively
25 screening part of the article from conditioning means, wherein the position of the screen is adjustable relative to each of the conditioning device and an article held by the holder.

The provision of an adjustable screen, which surrounds at least part of the article and screens it from the conditioning means, enables more precise and/or accurate and/or elaborate conditioning profiles
30 to be achieved.

The conditioning device may comprise a heating device. This invention is particularly concerned with heating devices, but the skilled person will appreciate that many of the principles described herein

may be used in other types of conditioning devices. For example, the conditioning device may comprise a curing device or a device for carrying out other treatments that would be appreciated by the skilled person. Additionally or alternatively, the conditioning device may comprise a cooling device.

5

The article may be a tubular article, such as a preform. The conditioning system may be for conditioning tubular articles, such as preforms. The conditioning system may, but need not, be a preform conditioning system. The holder may comprise a tubular article holder or a preform holder.

10 The conditioning device may be configured to irradiate the article or preform with electromagnetic radiation, such as infrared or microwave radiation. The holder may be for, e.g. suitable for, holding an article or preform to be irradiated by electromagnetic radiation from the heating device.

Another broad aspect of the invention provides a preform conditioning system comprising: a heating
15 device; a preform holder for holding a preform to be irradiated by electromagnetic radiation from the heating device; and a screen shaped and configured to at least partially surround a preform held, in use, by the preform holder for selectively screening part of the preform from electromagnetic radiation; wherein the position of the screen is adjustable relative to each of the heating device and a preform held by the preform holder.

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The provision of an adjustable screen, which surrounds at least part of the preform and screens it from the heating device, facilitates more precise, accurate and elaborate temperature profiles. The skilled person will appreciate that this enables better material distribution, thereby reducing the quantity of material required to achieve the required performance. The skilled person will also appreciate that this
25 can facilitate more elaborate container shapes to be formed during the blow molding process, and improve the repeatability of preform inflation thereby providing a more stable process.

The conditioning system may comprise an adjustment mechanism. The adjustment mechanism may be operatively connected to or associated with the holder, or may be operable completely independent
30 of the holder. The screen may be operatively connected to the adjustment mechanism, e.g. by a connection means or connector.

Another broad aspect of the invention provides an adjustable screen, e.g. for use in the aforementioned conditioning system. The screen may be shaped and configured to at least partially surround and selectively screen part of an article or preform from electromagnetic radiation. The screen may comprise a connecting feature, e.g. for connecting to the or an adjustment mechanism of the conditioning system. The adjustable screen may comprise and/or be operatively connected to an adjustment mechanism.

The heating device may comprise a heating zone. An article or preform held, in use, by the holder may be irradiated in the heating zone. The system or heating device or heating zone may comprise a first side. The system or heating device or heating zone may comprise a second side, which may be opposite the first side.

The holder may be positionable or deployable such that an article or preform held, in use, by the holder may be irradiated in the heating zone. The holder may be positionable or deployable such that an article or preform held, in use, by the holder extends into the heating zone. The holder may be positionable or deployable such that an article or preform held, in use, by the holder extends from the or a first side of the heating zone.

The screen may be positionable or deployable to extend into the heating zone, e.g. to reduce an effective depth of the heating zone. The screen may be positionable or deployable to extend from the or a first side of the heating zone. Alternatively, the screen may be positionable or deployable to extend from the or a second side of the heating zone, which may be opposite the first side thereof.

The screen may comprise a first screen. The conditioning system may comprise a second screen. The conditioning system may comprise a second adjustment mechanism. The second screen may be operatively connected to the second adjustment mechanism, e.g. by a connection means or connector. Alternatively, the second screen may be operatively connected, e.g. by a connection means or connector, to the same adjustment mechanism that the first screen is connected to. The second adjustment mechanism may be operatively connected to or associated with the holder, or may be operable completely independent of the holder.

The first screen may be positionable or deployable to extend from the or a first side of the heating zone and/or the second screen may be positionable or deployable to extend from the or a second side

of the heating zone, which may be opposite the first side thereof. An effective depth of the heating zone may be described or defined between the first and second screens.

At least one or each screen may comprise a tubular or part-tubular member. At least one or each screen may comprise a sleeve. At least one or each sleeve may be substantially continuous, e.g. to surround the article entirely. At least one or each sleeve may be discontinuous or may have one or more holes, slits or apertures therethrough. For example, at least one or each screen or sleeve could comprise a slitted tube or a grid tube. At least one or each screen may be coaxial with and/or at least partially surround the holder and/or a preform held by the holder. The axial position of at least one or each screen may be adjustable relative to the holder and/or relative to a preform held by the holder. Additionally or alternatively, the axial position of at least one or each screen may be adjustable relative to the heating device.

At least one or each sleeve may be rotatable, e.g. about its longitudinal axis and/or about an axis of the preform. This may be particularly advantageous when the sleeve is discontinuous or has holes, slits or apertures therethrough.

The heating zone may have a depth, e.g. across which an article or preform held, in use, by the holder may be irradiated. At least one or each screen may be positionable or deployable to extend across part of the depth of the heating zone. The system or heating device may comprise at least one opening or space.

The opening or space, or a first of the opening(s) or space(s), may be at or on the first side. The holder or an article or preform held by the holder may extend through the opening or space, e.g. the first opening or space, into the heating zone. The screen or first screen may extend through the opening or space, e.g. the first opening or space, into the heating zone. In some examples, the first and second screen may both extend through the opening or space, e.g. the first opening or space, into the heating zone.

The opening or space, or a second of the opening(s) or space(s), may be at or on the second side of the heating zone. The opening or space, e.g. the second opening or space, may be for, or suitable for, receiving a portion of an article or preform held, in use, by the holder, e.g. when the article or preform

spans the depth of the heating zone. The screen or second screen may extend through the opening or space, e.g. the second opening or space, into the heating zone.

The holder may be movable, e.g. relative to the screen and/or relative to the heating device. The holder may be movable to selectively position, in use, a region of the article or preform to be irradiated between the screen, e.g. the first screen, and the second side of the heating zone. The holder may be movable to selectively position, in use, a region of the article or preform to be irradiated between the screen, e.g. the second screen, and the first side of the heating zone. The holder may be movable to selectively position, in use, a region of the article or preform to be irradiated between the first and second screens, e.g. when two screens are present and/or when each screen extends from a respective side of the heating zone.

At least one or each screen may be retractable, e.g. from the heating device or heating zone. At least one or each screen may be deployable, e.g. into the heating device or heating zone. At least one or each screen may be positionable or deployable to span a predetermined proportion of the depth of the heating zone. At least one or each screen may be positionable or deployable to span at least 10%, for example at least 20% or at least 25%, of the depth of the heating zone. At least one or each screen may be positionable or deployable to span at least 30%, for example at least 40% or at least 50% of the depth of the heating zone. In some examples, at least one or each screen may be positionable or deployable to span the entire depth of the heating zone.

At least one or each screen may comprise an abutment or stop, which may cooperate with a corresponding abutment or stop of the heating device, e.g. to limit the depth to which the screen may be positioned in or into the heating zone. At least one or each screen may comprise a step, which may include or provide the or an abutment or stop. The abutment or stop may extend radially and/or may comprise a radial and/or annular surface. The cooperating abutments or stops of the screen and the heating device may inhibit the screen from extending more than a predetermined proportion of the depth of the heating zone. The predetermined proportion may be 25% or 50% or 75% or 90%.

At least one or each screen may be positionable or deployable to span up to 25% of the depth of the heating zone. At least one or each screen may be prevented from spanning more than 25% of the depth of the heating zone. At least one or each screen may be positionable or deployable to span up to 50% of the depth of the heating zone. At least one or each screen may be prevented from spanning more

than 50% of the depth of the heating zone. At least one or each screen may be positionable or deployable to span up to 75% of the depth of the heating zone. At least one or each screen may be prevented from spanning more than 75% of the depth of the heating zone. At least one or each screen may be positionable or deployable to span up to 90% of the depth of the heating zone. At least one or
5 each screen may be prevented from spanning more than 90% of the depth of the heating zone.

At least one or each screen may be adjustable or deployable to extend into the heating zone to a position, for example a predetermined position. At least one or each screen may be adjustable or deployable to extend into the heating zone to one of two or more positions, which may be
10 predetermined positions. At least one or each screen may be step-wise adjustable or continuously or infinitely adjustable, e.g. to extend into the heating zone to a position, for example any one of a two or more or a plurality of positions. At least one or each screen may be adjustable or deployable continuously or intermittently or in a step-wise movement.

15 At least one or each or both of the first and second screens may be adjustable toward and/or away from one another, e.g. when the first screen extends from the first side and the second screen extends from the second side. In some examples, the abutments or stops may prevent screens from contacting one another. In other examples no abutments or stops are included, or only one of the screens may include an abutment or stop. In such examples, the second screen may be smaller than the first screen,
20 e.g. such that it may enter the first screen. In such examples, the second screen may have a smaller outer diameter than the inner diameter of the first screen, e.g. such that it may enter the first screen.

At least one of the screens may comprise or provide or function as a shield, e.g. to inhibit or prevent electromagnetic radiation from passing therethrough and/or from irradiating the portion of the article
25 or preform it surrounds. At least one of the screens may comprise or provide or function as a filter, e.g. to allow only a portion of the electromagnetic radiation therethrough and/or some or certain electromagnetic wavelengths to pass therethrough and/or to mask a portion of the electromagnetic radiation or to inhibit some or certain electromagnetic wavelengths from passing therethrough. The screen or filter may be configured to allow some or certain, e.g. only some or certain, electromagnetic
30 wavelengths to pass therethrough and irradiate the portion of the article or preform it surrounds. The screen or filter may be configured to inhibit or prevent some or certain, e.g. only some or certain, electromagnetic wavelengths from passing therethrough and/or from irradiating the portion of the article or preform it surrounds.

In some examples, the second screen may be nested within the first screen and/or may be movable, e.g. axially, relative to the first screen. In such examples, the first and second screen may both extend from the first side and/or through the first opening. This may be useful where one of the screens performs one function and another performs a different function. For example, one of the screens, e.g. the first screen, may comprise or provide or function as a shield, while another of the screens, e.g. the second screen, may comprise or provide or function as a filter.

The heating device may comprise a resonator. The resonator may describe the heating zone. The screen may be configured to shield, in use, the article or preform from at least some microwave energy.

Additionally or alternatively, the screen may be configured to shield, in use, the article from at least some infrared frequencies, e.g. with a screen which is partially infrared transparent.

The screen may comprise a metallic or dielectric material. Additionally or alternatively, the screen may comprise a ceramic or polymeric material. Additionally or alternatively, the screen may be partially microwave transparent.

When the screen comprises or provides or functions as a filter, it may comprise one or more apertures, holes, openings, slits, or passageway through its thickness. Additionally or alternatively, the screen may comprise a material that is partially infrared or microwave transparent, for example which is configured to filter some but not all electromagnetic wavelengths.

The system may be operable or configured to adjust, in use, one or more characteristics of the conditioning means or electromagnetic radiation, e.g. in dependence upon the position of the screen. In some examples, the system may be operable or configured to adjust, in use, the power or intensity of the electromagnetic radiation, for example up or down, in dependence upon the position of the screen and/or the effective depth of the heating zone. Preferably, the system is operable or configured to reduce, in use, the power or intensity of the electromagnetic radiation, e.g. in response to the screen being moved into the heating zone. More preferably, the system is operable or configured to reduce, in use, the power or intensity of the electromagnetic radiation by an amount that is at least partially dependent upon the extent to which the screen extends into the heating zone and/or relative to the effective depth of the heating zone.

The screen may be movably mounted to the holder. In some examples, the screen may be resiliently mounted to the holder, e.g. for movement therewith into the heating device. In such examples, the abutment or stop of the screen may be configured to engage the abutment or stop of the heating device
5 when the screen reaches a predetermined position, e.g. within the heating device or within the heating zone.

The system, or the heating device, may comprise an infeed tube, e.g. through and/or along which the holder and/or preform held by the holder may be received and/or movable. In some examples, the
10 screen is movably mounted to the or an infeed tube of the system, or of the heating device.

The screen may be grounded. The screen may be electrically connected, e.g. may comprise a grounding connection, to the heating device, resonator and/or infeed tube.

15 Another broad aspect of the invention provides a method of conditioning an article. The method may, but need not, comprise adjusting the position of a screen, e.g. relative to an article to be conditioned. The position of the screen may, but need not, be adjusted such that the screen at least partially surrounds the article. The method may, but need not, comprise subjecting the article to conditioning means. The article may, but need not, be subjected to the conditioning means whilst part of the article
20 is screened from the conditioning means by the screen.

Another broad aspect of the invention provides a method of conditioning an article, the method comprising adjusting the position of a screen relative to an article to be conditioned such that the screen at least partially surrounds the article and subjecting the article to conditioning means whilst
25 part of the article is screened from the conditioning means by the screen.

The conditioning means may comprise heating means. The conditioning means may comprise electromagnetic radiation. The method may comprise emitting electromagnetic radiation, such as infrared or microwave radiation, toward the article. The electromagnetic radiation may be emitted
30 whilst part of the article is screened from the electromagnetic radiation by the screen.

Another broad aspect of the invention provides a method of conditioning or heating an article, the method comprising adjusting the position of a screen relative to an article to be conditioned or heated

such that the screen at least partially surrounds the article and emitting electromagnetic radiation toward the article whilst part of the article is screened from the electromagnetic radiation by the screen.

5 The article may be a tubular article, such as a preform. The method may comprise a method of conditioning or heating tubular articles, such as preforms.

10 The method may comprise holding the article with a holder, e.g. whilst it is irradiated with electromagnetic radiation. The method may comprise positioning the screen relative to an article held by the or a holder. The method may comprise emitting electromagnetic radiation toward the article held by the or a holder, e.g. whilst part of the article is screened from the electromagnetic radiation by the screen.

15 The article may be conditioned or irradiated in a heating zone. The article may extend into the heating zone, e.g. from a first side thereof. The screen may be moved into and/or positioned in or within the heating zone. The method may comprise positioning the article to be conditioned such that it extends into a heating zone, e.g. from a space or opening which may be at a first side of the heating zone.

20 The screen may be moved or positioned to extend into the heating zone, e.g. to reduce an effective depth of the heating zone. The screen may be moved or positioned to extend from the or a first side of the heating zone. Adjusting the position of the screen may comprise inserting a sleeve into the heating zone, for example from the space or opening. Alternatively, the screen may be moved or positioned to extend from a second side of the heating zone, which may be opposite the first side thereof. The second side may have a space or opening, e.g. through which the article and/or the screen may or may be positioned to extend.

25 The screen may comprise a first screen. The method may comprise adjusting the position of a second screen relative to the article to be conditioned or heated, e.g. such that the screen at least partially surrounds the article. The method may comprise positioning the article such that it extends through the heating zone. The method may comprise positioning the article such that it extends into a space or opening, which may be at a second side of the heating zone. The second side may be opposite the first side. The method may comprise inserting the second sleeve into the heating zone, for example from the space or opening at the second side thereof.

30

The method may comprise subjecting the article to conditioning means whilst one or more parts of the article is or are screened from the conditioning means by the first and second screens. The method may comprise emitting electromagnetic radiation toward the article whilst one or more parts of the article is or are screened from the electromagnetic radiation by the first and second screens.

5

The method may comprise moving or positioning the first screen to extend from the or a first side of the heating zone and/or moving or positioning the second screen to extend from the or a second side of the heating zone, which may be opposite the first side thereof. An effective depth of the heating zone may be described or defined between the first and second screens.

10

The screen may comprise a tubular or part-tubular member. The screen may comprise a tubular member, such as a sleeve, for surrounding, e.g. completely surrounding, part of the article. At least one or each sleeve may be substantially continuous, e.g. to surround the article entirely. At least one or each sleeve may be discontinuous or may have one or more holes, slits or apertures therethrough.

15 For example, at least one or each screen could comprise a slitted tube or a grid tube. The screen may be moved or positioned to extend across part of a depth of the heating zone.

The method may comprise rotating or at least one sleeve, e.g. about its longitudinal axis and/or about an axis of the preform. The method may comprise rotating or at least one discontinuous or holed,
20 slitted or apertured sleeve, e.g. about its longitudinal axis and/or about an axis of the preform.

The article may extend through an opening or space, e.g. a first opening or space, on the or a first side of the heating zone. Or at least one of the screen(s) may extend through the opening or space, e.g. the first opening or space, into the heating zone. In some examples, the first and second screen may both
25 extend through the opening or space, e.g. the first opening or space, into the heating zone.

The article may be moved or positioned such that a portion thereof extends through the or a second opening or space on the or a second side of the heating zone. The article may be moved or positioned such that it extends through the first opening or space, spans the depth of the heating zone and extends
30 through the second opening or space.

The method may comprise moving the article to two or more different positions, e.g. to condition or irradiate different parts of the article. The method may comprise moving the screen to two or more different positions, e.g. to screen different parts of the article at different times.

5 The method may comprise moving at least one of the screens to various positions up to one of the depths described above. The method may comprise moving at least one of the screens until the or an abutment or stop of the screen abuts or engages the or an abutment or stop of the or a heating device. The method may comprise moving at least one of the screens continuously or intermittently or in a step-wise movement.

10

The method may comprise moving the first and second screens toward and/or away from one another, for example to isolate a predetermined region of the article and/or to screen conditioning or heating means or electromagnetic radiation at a predetermined location.

15 The method may comprise shielding the article with the screen, e.g. to inhibit or prevent electromagnetic radiation from passing therethrough and/or from irradiating the portion of the article it surrounds. The method may comprise filtering the conditioning means or electromagnetic radiation with the screen, e.g. to allow only a portion of the electromagnetic radiation therethrough and/or some or certain electromagnetic wavelengths to pass therethrough and/or to mask a portion of the
20 electromagnetic radiation or to inhibit some or certain electromagnetic wavelengths from passing therethrough. The method may comprise shielding the article with the first screen and/or filtering the conditioning means or electromagnetic radiation with the second screen.

The method may comprise emitting electromagnetic radiation with a resonator, which may describe
25 the heating zone. The electromagnetic radiation may comprise microwaves or microwave energy. The method may comprise shielding the article from at least some microwave energy. The method may comprise shielding the article with a screen formed at least in part of a metallic or dielectric material. The method may comprise shielding the article with a screen formed at least in part of a ceramic or polymeric material. The method may comprise shielding the article with a screen which is partially
30 microwave transparent.

Additionally or alternatively, the method may comprise emitting infrared radiation. The electromagnetic radiation may comprise infrared energy. The method may comprise shielding the

article from at least some infrared frequencies. The method may comprise shielding the article with a screen which is partially infrared transparent.

The method may comprise moving the screen through and/or along an infeed tube. The method may
5 comprise moving the holder and screen together until the abutment or stop of the screen engages the
abutment or stop of the heating device when the screen reaches a predetermined position, e.g. within
the heating device or within the heating zone. The method may comprise flexing a resilient means
when the abutments or stops engage, thereby to enable the holder to continue to move whilst inhibiting
or preventing further movement of the screen.

10 The method may comprise adjusting one or more characteristics of the conditioning means or
electromagnetic radiation in dependence upon the position of the screen. In some examples, the power
or intensity of the electromagnetic radiation may be adjusted, for example up or down, in dependence
upon the position of the screen and/or the effective depth of the heating zone. Preferably, the power
15 or intensity of the electromagnetic radiation is reduced, e.g. in response to the screen being moved
into the heating zone. More preferably, the power or intensity of the electromagnetic radiation is
reduced by an amount that is at least partially dependent upon the extent to which the screen extends
into the heating zone and/or relative to the effective depth of the heating zone.

20 Another aspect of the invention provides a computer program element comprising and/or describing
and/or defining a three-dimensional design, e.g. of the screen described above or an embodiment
thereof. The three-dimensional design may be for use with a simulation means or an additive or
subtractive manufacturing means, system or device.

25 The computer program element may be for causing, or operable or configured to cause, an additive or
subtractive manufacturing means, system or device to manufacture the screen described above or an
embodiment thereof. The computer program element may comprise computer readable program code
means for causing an additive or subtractive manufacturing means, system or device to execute a
procedure to manufacture the screen described above or an embodiment thereof.

30 A yet further aspect of the invention provides the computer program element embodied on a computer
readable medium.

For the avoidance of doubt, any of the features described herein apply equally to any aspect of the invention. Within the scope of this application, it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken
5 independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible.

For the avoidance of doubt, the terms “may”, “and/or”, “e.g.”, “for example” and any similar term as used herein should be interpreted as non-limiting such that any feature so described need not be
10 present. Indeed, any combination of optional features is expressly envisaged without departing from the scope of the invention, whether or not these are expressly claimed. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

15

BRIEF DESCRIPTION OF THE DRAWINGS

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

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FIG. 1 depicts a conditioning system according to a first example, showing the screen shielding part of a preform from being subjected to electromagnetic radiation;

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FIG. 2 depicts the conditioning system of FIG. 1 without the screen, illustrating a temperature profile after irradiation of a portion of the preform;

FIG. 3 depicts an upper portion of a container formed using the arrangement shown in FIG. 2;

30

FIG. 4 depicts the conditioning system of FIG. 1 with the screen in its fully deployed position, illustrating a temperature profile after irradiation of a portion of the preform immediately below the neck region;

FIG. 5 depicts an upper portion of a container formed using the arrangement shown in FIG. 4;

FIG. 6 depicts a conditioning system according to a second example, showing the screen shielding part of a preform from being subjected to electromagnetic radiation; and

FIG. 7 depicts a conditioning system according to a third example, showing the screen shielding part of a preform from being subjected to electromagnetic radiation.

DETAILED DESCRIPTION OF THE INVENTION

With reference to FIG. 1, there is shown a preform conditioning system 100 including a heating device 101, a preform holder 102 for holding a preform P to be irradiated by electromagnetic radiation ER from the heating device 101 and a screen 103 shaped and configured to surround part of the preform P for selectively screening it from the electromagnetic radiation ER. The screen 103 is connected to an adjustment mechanism 104 by a connector 130, for adjusting its position along arrows A₁ relative to each of the heating device 101 and the preform P held by the preform holder 102. In this example, the screen 103 is movably mounted within an infeed tube 105 to which the adjustment mechanism 104 is mounted.

The heating device 101 is a resonator in this example, which includes an applicator 111 describing a heating zone 112 having a depth D, and a source 113 of electromagnetic radiation ER at a first end of the heating zone 112 on one side of the preform P. The electromagnetic radiation ER is in the form of microwaves in this example, and the portion of the microwaves emitted from the source 113 pass between adjacent preforms P travel across the applicator 111 and are reflected back off the opposite wall to irradiate the opposite side of the preform P. The applicator 111 includes a first opening 114 through its upper wall 111a, which leads to a first side of the heating zone 112 (shown more clearly in FIG. 2). In this example, the applicator 111 includes a radial ledge 116 in the first opening 114, which provides an abutment or stop 116a. The applicator 111 also includes a second opening 115 through its lower wall 111b, which leads to a second side of the heating zone 112, opposite the first side.

The preform holder 102 in this example includes a rod 120 with an expandable gripper 121 at its lower end. The expandable gripper 121 is configured to be inserted into the neck opening of the preform P, and expanded to engage the inner surface of the neck opening of the preform P. The skilled person

will appreciate that this form of preform holder 102 is but one example, and any suitable preform holder 102 may be used without departing from the scope of the invention. The preform holder 102 is movable along arrows A_2 to adjust the position of the preform P within the heating zone 112.

5 The screen 103 is a sleeve in this example, which has a substantially cylindrical shape and is coaxial with, and surrounds, the preform holder 102. Other tubular or part-tubular shapes are also envisaged without departing from the scope of the invention. The screen 103 is movable relative to the preform holder 102 along arrows A_1 , to any one of various axial positions relative to the preform P. As such, the screen 103 may be deployed to cover more, or retracted to cover less, of the axial length of the
10 preform P. This movement is independent of the movement of the preform holder 102 in this example.

The screen 103 also includes a step 131 on its outer surface, which delineates an insertion portion 132 of the sleeve. The insertion portion 132 is configured to be inserted through the first opening 114 in the upper wall 111a of the applicator 111, such that it extends into the heating zone 112 from the first
15 side thereof. The step 131 also functions as an abutment or stop 131a which cooperates with the stop 116a of the applicator 111, thereby to limit the depth to which the screen 103 may be inserted into the heating zone 112.

In this example, the screen 103 is formed of aluminium. However, it is envisaged that the screen 103
20 may comprise any material capable of shielding, or at least partially shielding, the preform P from electromagnetic radiation. The screen 103 may, in particular, comprise a metallic, dielectric, ceramic or polymeric material. In some examples, the screen 103 may be partially microwave transparent, for example to allow some electromagnetic energy to pass therethrough, whilst blocking other electromagnetic wavelengths.

25 In use, the preform holder 102 lowers and raises the preform P into the requisite position within the heating zone 112 along arrows A_2 . The movement of the screen 103 relative to the preform P along arrows A_1 is independent of the movement of the preform holder 102. This enables the preform P to be moved into position within the heating zone 112, for heating a predetermined region of the preform
30 P, whilst moving the screen 103 independently to selectively shield a surrounded portion of the preform P from the electromagnetic radiation ER. This enables the electromagnetic radiation ER to be focused on the exposed region of the preform P, between the end of the screen 103 and the lower wall 111b of the applicator 111.

Referring now to FIG. 2, the preform conditioning system 100 is shown without the screen 103 or the infeed tube 105, similar to a situation in which the screen 103 is fully retracted. FIG. 2 also shows a temperature profile TP_1 of along the height H after the portion of the preform P within the heating zone 112 has been exposed to electromagnetic radiation ER for a predetermined period of time, 5 seconds in this example. As is apparent from FIG. 2, the temperature is at its highest at the centre of the preform portion within the heating zone 112.

As is also apparent from FIG. 2, the neck region of the preform P is outside of the heating zone 112, to avoid overheating of this area. As a result, the temperature of the preform P immediately below the neck region is relatively low.

FIG. 3 shows the material distribution of a bottle 106 formed from the preform P heated in this manner. The thick transition portion of the bottle 106 between the neck region and the body is the result of insufficient heat in the portion of the preform P immediately below the neck region, which results in the hot and malleable portion of the preform P folding over the cooler portion. The skilled person will appreciate that the rest of the body of the preform P will have been subjected to further conditioning prior to blowing. FIG. 3 merely illustrates the material distribution of a blown bottle 106 resulting from the limited extent to which heat can be focused on the region of the preform P immediately below the neck region.

Referring now to FIG. 4, the preform conditioning system 100 is shown with the screen 103 in a fully deployed position, wherein the stop 131a of the screen 103 abuts the stop 116a of the applicator 111. In this example, the insertion portion 132 extends across half of the depth D of the heating zone 112. The preform P is positioned such that the neck region is immediately above the lower edge of the screen 103, to avoid overheating of this area.

However, unlike the arrangement of FIG. 2 the electromagnetic radiation ER is prevented from travelling across the upper half of the heating zone 112. As such, the electromagnetic radiation ER is focused on the region immediately below the neck region of the preform, where the preform P is exposed to the heating zone 112. Thus, the effective depth D_1 of irradiation corresponds to the lower half of the heating zone 112, or the portion of the depth D of the heating zone 112 between the end of the screen 103 and the lower wall 111b of the applicator 111.

FIG. 4 also shows a temperature profile TP_2 after the exposed portion of the preform P, aligned with the effective depth D_1 of the heating zone 112, has been irradiated for a predetermined time, 15 seconds in this example. This illustrates that the electromagnetic radiation ER may be focused effectively on the region of the preform P immediately below the neck region. The temperature profile TP_2 also shows that the temperature drops drastically between the centre of the irradiated zone of the preform P and the neck region, which provides a more effective means of heating the portion of the preform P immediately below the neck region, whilst mitigating any distortion of the neck region.

FIG. 5 shows the material distribution of a bottle 106' formed from the preform P heated in this manner. The transition portion of the bottle 106' between the neck region and the body is much thinner than that of the bottle 106 shown in FIG. 3, which is the result of the portion of the preform P immediately below the neck region itself being much more hot and malleable. As with the previous example, the preform P will have been subjected to further conditioning prior to blowing. FIG. 5 merely illustrates the material distribution of a blown bottle 106' resulting from the increased focus of heat, concentrated in the region of the preform P immediately below the neck region.

The skilled person will appreciate that the aforementioned improvement in heating of the portion of the preform P immediately below the neck region is merely one example of the benefits of the invention. The temperature profile of the preform P as it passes through the conditioning system 100 may be varied to suit the required bottle shape. The invention enables a more focused application of electromagnetic radiation ER to predetermined regions of the preform P. The skilled person will appreciate that this may be particularly helpful in the case of complex bottle shapes.

Turning now to FIG. 6, there is shown a preform conditioning system 200 according to another example, which is similar to the preform conditioning system 100 of FIG. 1 wherein like references depict like features incremented by 100. The preform conditioning system 200 according to this example differs from the previous example in that the insertion portion 232 of the screen 203 is longer, spanning three quarters of the depth D of the heating zone 212.

As such, the effective depth D_2 of irradiation for the preform conditioning system 200 corresponds to one quarter of the heating zone 212, or the portion of the depth D of the heating zone 212 between the end of the screen 203 and the lower wall 211b of the applicator 211. It will be appreciated that the

adjustment mechanism 204 may be operated to adjust the effective depth D_2 as required, rather than deploying the screen 203 fully to the point where the stops of the screen 203 and applicator 111 are engaged, as illustrated.

5 Turning now to FIG. 7, there is shown a preform conditioning system 300 according to yet another example, which is similar to the preform conditioning system 100 of FIG. 1 wherein like references depict like features incremented by 200. The preform conditioning system 300 according to this example differs from the first example in that it includes two screens 303, 303' and the insertion portion 332, 332' of each screen 303, 303' is shorter, spanning slightly less than half of the depth D
10 of the heating zone 312.

More specifically, the second screen 303' is substantially the same as the first screen 303 but extends through the second opening 315, is connected to an adjustment mechanism 304' by a connector 330' and is adjustable along arrows A_3 relative to each of first screen 303, the heating device 301 and the
15 preform P held by the preform holder 302. The movement of the second screen 303 along arrows A_3 is independent of the movement of each of the first screen 303 and of the preform holder 302. This enables the electromagnetic radiation ER to be focused on the exposed region of the preform P, between the facing ends of each screen 303, 303'.

20 The second opening 315 also includes radial ledge 316, which provides a stop for engaging the stop of the second screen 303', thereby to limit the depth to which the second screen 303' may be inserted into the heating zone 312. In this example, deploying both screens 303, 303' fully to the point where the stops of the screens 303, 303' and applicator 311 are engaged results in a very narrow effective depth D_3 .

25 However, both adjustment mechanisms 304, 304' may be operated together or independently to adjust both the effective depth D_3 and its position relative to the preform P, as required. The skilled person will appreciate that this provides an even more versatile preform conditioning system 300, able to isolate very narrow bands of the preform P to provide highly focused heating.

30 In this example, the screens 303, 303' are formed of aluminium, but as with the example of FIG. 1 it could include other materials. In fact, the first screen 303 could be configured to shield the preform P from electromagnetic radiation ER, whilst the second screen 303' could be partially microwave

transparent, for example to allow some electromagnetic wavelengths to pass therethrough, whilst blocking other electromagnetic wavelengths.

5 In alternative examples, the insertion portion 332, 332' of each screen 303, 303' may be longer, in some cases long enough to span the entire depth D. In such examples, the position of each screen 303, 303' could be adjusted infinitely to expose any portion of the preform P, which is to say to adjust the effective depth D_3 as required, and to position the gap at any location within the heating zone 312.

10 It is also envisaged that both screens 303, 303' could extend through the first opening, for example with the second screen 303' being nested within the first screen 303. In such examples, it may be beneficial for the second screen to be partially microwave transparent, thereby shielding a first portion of the preform P from any electromagnetic radiation ER whilst shielding only certain wavelengths from a second portion of the preform P.

15 The adjustment mechanism 104, 204, 304 is also but one example of how the screen 103, 203 or first screen 303 may be adjusted. Other arrangements are also envisaged. For example, the screen 103 may be resiliently mounted to the preform holder 102 for movement therewith into the heating device 101 until the stop 131a of the screen 103 engages the stop 116a of the applicator 111. Continued movement of the preform holder 102 would then be possible by virtue of the resilient connection between it and
20 the screen 103.

It will also be appreciated by those skilled in the art that several variations to the construction and/or use of aforementioned examples are envisaged without departing from the scope of the invention. It will also be appreciated by those skilled in the art that any number of combinations of the
25 aforementioned features and/or those shown in the appended drawings provide clear advantages over the prior art and are therefore within the scope of the invention described herein.

CLAIMS

1. A preform conditioning system (100, 200, 300) comprising:
 - a heating device (101, 201, 301);
 - 5 a preform holder (102, 202, 302) for holding a preform (P) to be irradiated by electromagnetic radiation (ER) from the heating device (101, 201, 301); and
 - a screen (103, 203, 303) shaped and configured to at least partially surround a preform (P) held, in use, by the preform holder (102, 202, 302) for selectively screening part of the preform (P) from electromagnetic radiation (ER);
 - 10 wherein the position of the screen (103, 203, 303) is adjustable relative to each of the heating device (101, 201, 301) and a preform (P) held by the preform holder (102, 202, 302).
2. System (100, 200, 300) according to claim 1, wherein the screen (103, 203, 303) comprises a sleeve which is coaxial with and surrounds the preform holder (102, 202, 302) and the axial
15 position of the sleeve is adjustable relative to each of the preform holder (102, 202, 302) and the heating device (101, 201, 301).
3. System (100, 200, 300) according to claim 2, wherein the heating device (101, 201, 301) comprises a heating zone (112, 212, 312) having a depth (D) across which a preform (P) held,
20 in use, by the preform holder (102, 202, 302) is irradiated and the sleeve is positionable to extend into the heating zone (112, 212, 312) from a first side thereof and across part of its depth (D).
4. System (100, 200, 300) according to claim 3 comprising an opening (115, 215, 315) on a second side of the heating zone (112, 212, 312), opposite the first side for receiving a portion of a
25 preform (P) held, in use, by the preform holder (102, 202, 302) when the preform (P) spans the depth of the heating zone (112, 212, 312), wherein the preform holder (102, 202, 302) is movable relative to the sleeve and heating device (101, 201, 301) to selectively position a region of the preform (P) to be irradiated between the sleeve and second side of the heating zone (112, 212, 312).
- 30 5. System (100, 200, 300) according to claim 3 or claim 4, wherein the sleeve is retractable from the heating zone (112, 212, 312).

6. System (100, 200, 300) according to any one of claims 3 to 5, wherein the sleeve is positionable to span at least 25% of the depth of the heating zone (112, 212, 312).
7. System (100, 200, 300) according to claim 6, wherein the sleeve is positionable to span at least 50% of the depth of the heating zone (112, 212, 312).
8. System (100, 200, 300) according to any one of claims 3 to 7, wherein the sleeve is adjustable to extend into the heating zone (112, 212, 312) to one of two or more positions.
9. System (300) according to any one of claims 3 to 8, wherein the sleeve comprises a first sleeve and the system comprises a second sleeve which is positionable to extend into the heating zone (312) from a second side thereof, opposite the first side, and across part of its depth (D), wherein the second sleeve is shaped and configured to at least partially surround a preform (P) held, in use, by the preform holder (302) for selectively screening part of the preform (P) from electromagnetic radiation (ER).
10. System (300) according to claim 9, wherein the first and second sleeves are adjustable toward and/or away from one another.
11. System (100, 200, 300) according to any preceding claim, wherein the heating device (101, 201, 301) comprises a resonator describing the heating zone (112, 212, 312) and the screen (103, 203, 303) is configured to shield, in use, the preform (P) from at least some microwave frequencies.
12. System (100, 200, 300) according to claim 11, wherein the screen (103, 203, 303) comprises a metallic or dielectric material.
13. System (100, 200, 300) according to claim 9, wherein the screen (103, 203, 303) comprises a ceramic or polymeric material.
14. System (100, 200, 300) according to claim 9, wherein the screen (103, 203, 303) is partially microwave transparent.

15. System (100, 200, 300) according to any preceding claim, wherein the screen (103, 203, 303) is movably mounted to the preform holder (102, 202, 302).
16. System (100, 200, 300) according to claim 15, wherein the screen (103, 203, 303) is resiliently mounted to the preform holder (102, 202, 302) for movement therewith into the heating device (101, 201, 301), the screen (103, 203, 303) comprising a stop configured to engage a stop (116a, 316) of the heating device (101, 201, 301) when the screen (103, 203, 303) reaches a predetermined position within the heating device (101, 201, 301).
17. System (100, 200, 300) according to any one of claims 1 to 14, wherein the screen (103, 203, 303) is movably mounted to an infeed tube (105, 205, 305).
18. System (100, 200, 300) according to any preceding claim comprising an adjustment mechanism (104, 204, 304) to which the screen (103, 203, 303) is operatively connected by a connector (130, 330).
19. An adjustable screen (103, 203, 303) for use in a conditioning system (100, 200, 300) according to claim 18, the screen (103, 203, 303) comprising:
 - a sleeve shaped and configured to at least partially surround and selectively screen part of a preform (P) from electromagnetic radiation (ER); and
 - a connecting feature (130, 330) for connecting the sleeve to an adjustment mechanism (104, 204, 304) of the conditioning system (100, 200, 300).
20. A method of conditioning an article, the method comprising:
 - adjusting the position of a screen (103, 203, 303) relative to a preform (P) to be conditioned such that the screen (103, 203, 303) at least partially surrounds the preform (P); and
 - emitting electromagnetic radiation (ER) toward the preform (P) whilst part of the article is screened from the electromagnetic radiation (ER) by the screen (103, 203, 303).
21. Method according to claim 20 comprising:
 - positioning the preform (P) to be conditioned such that it extends into a heating zone (112, 212, 312) from an opening (114) at a first side of the heating zone (112, 212, 312);

wherein adjusting the position of the screen (103, 203, 303) comprises inserting a sleeve into the heating zone (112, 212, 312) from the opening (114) at the first side thereof.

22. Method according to claim 21 comprising adjusting the position of a second sleeve relative to the preform (P) such that the second sleeve at least partially surrounds the preform (P).

23. Method according to claim 22 comprising:
positioning the preform (P) such that it extends through the heating zone (312) and into an opening (315) at a second side of the heating zone (312), opposite the first side; and
inserting the second sleeve into the heating zone (312) from the opening (315) at the second side thereof.

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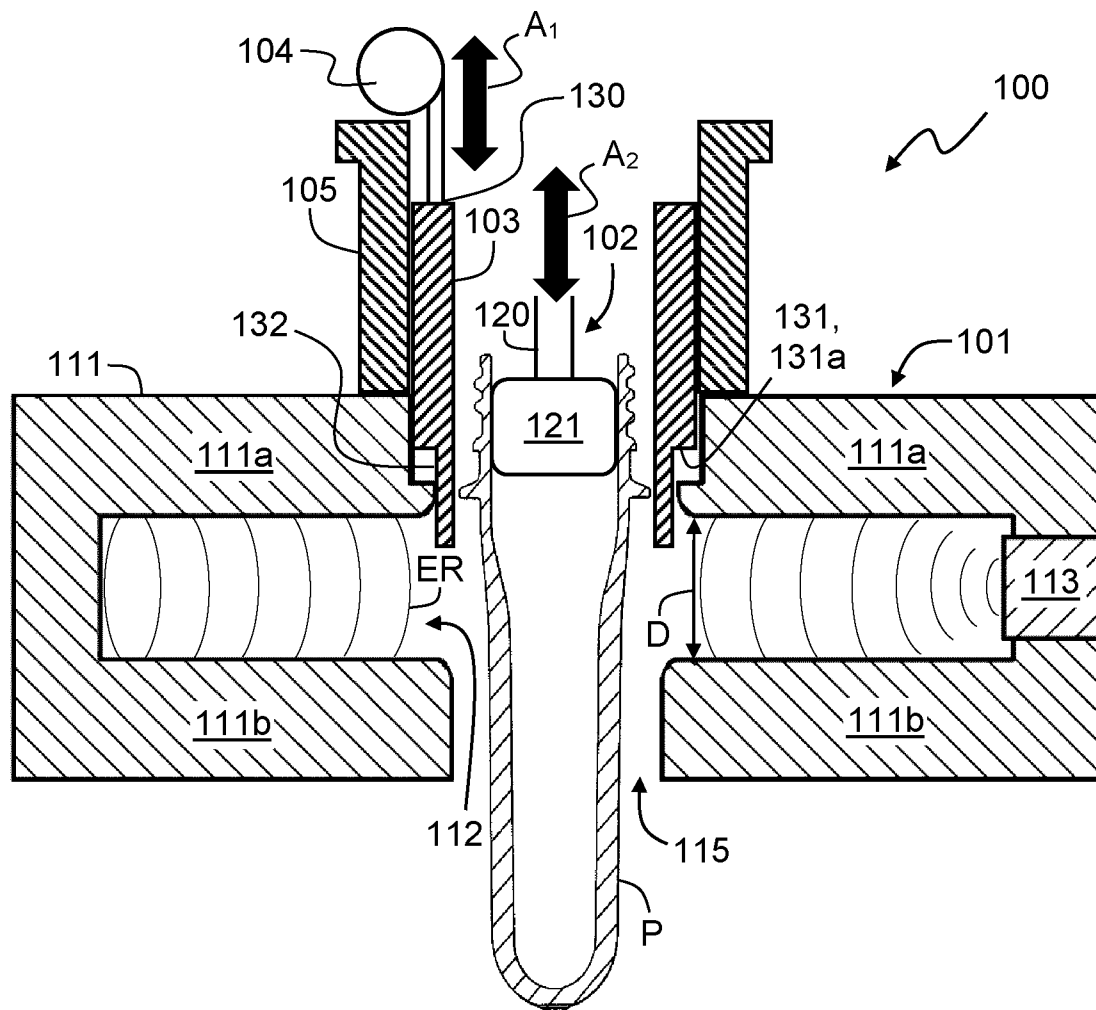


FIGURE 1

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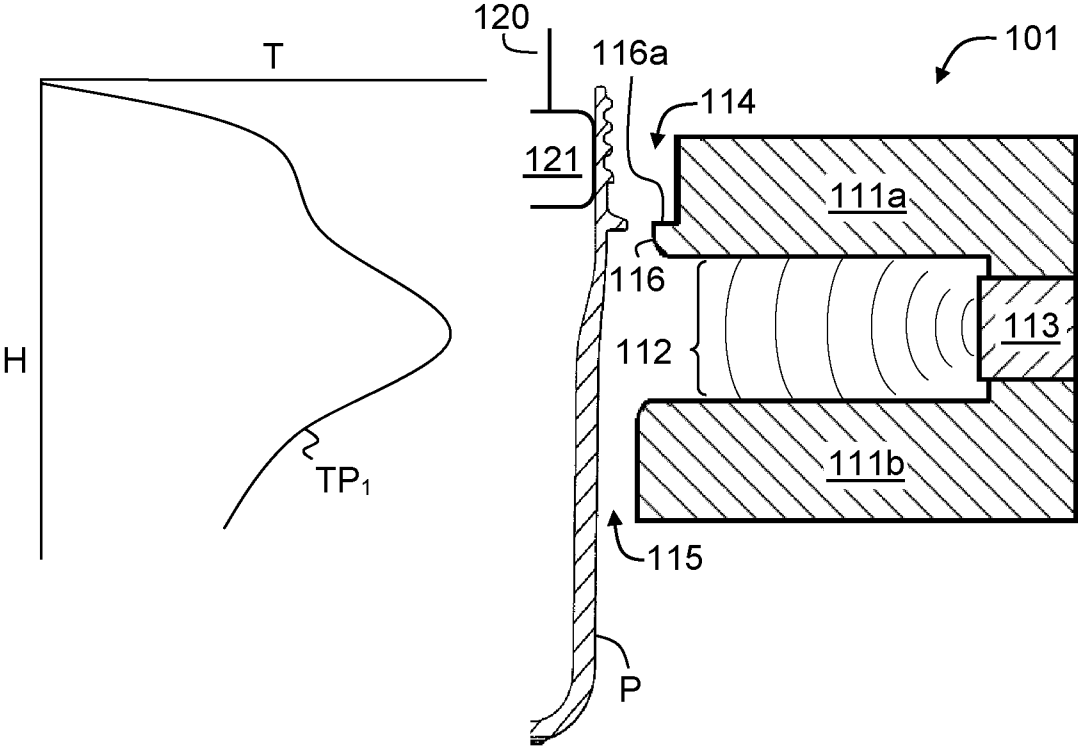


FIGURE 2

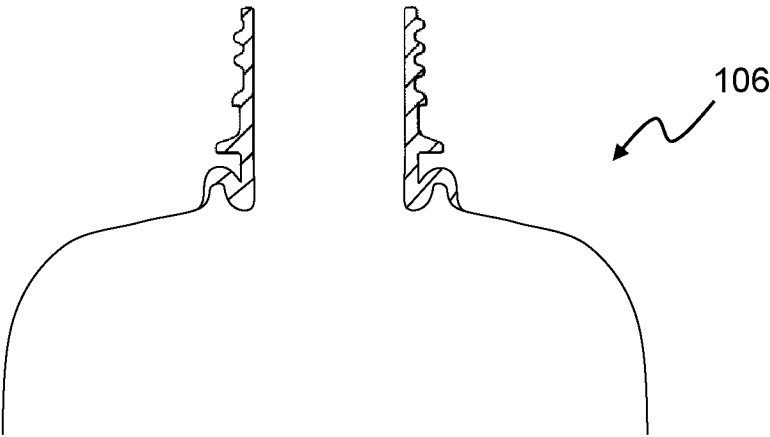


FIGURE 3

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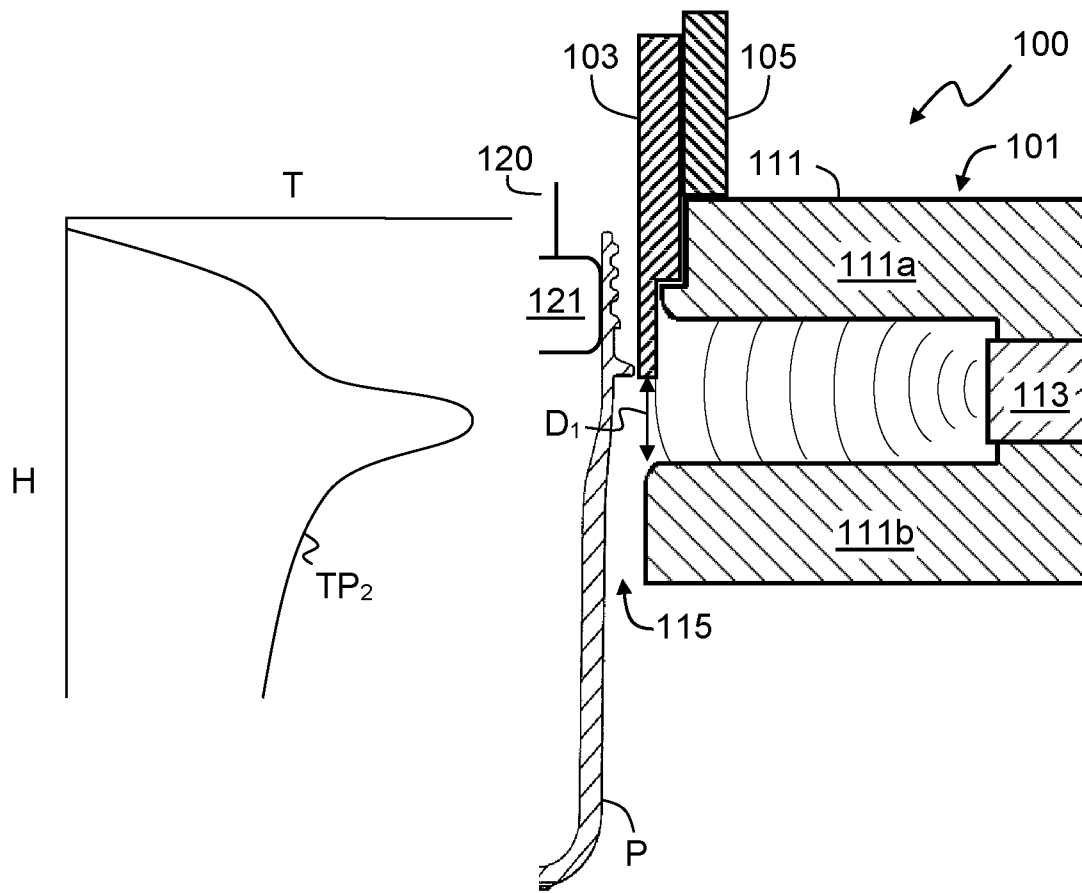


FIGURE 4

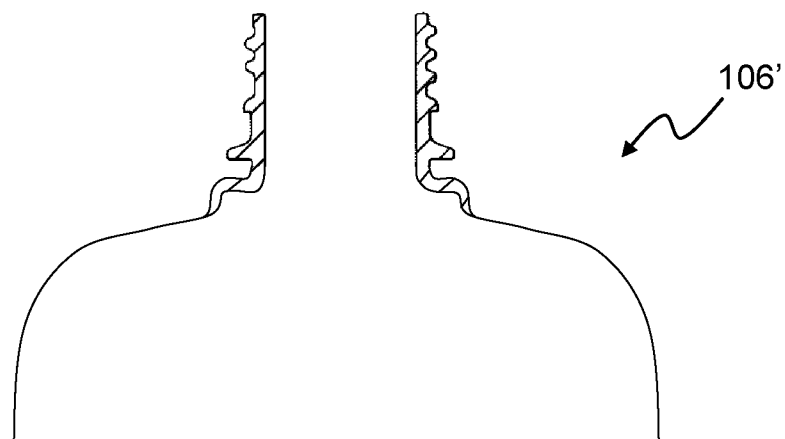


FIGURE 5

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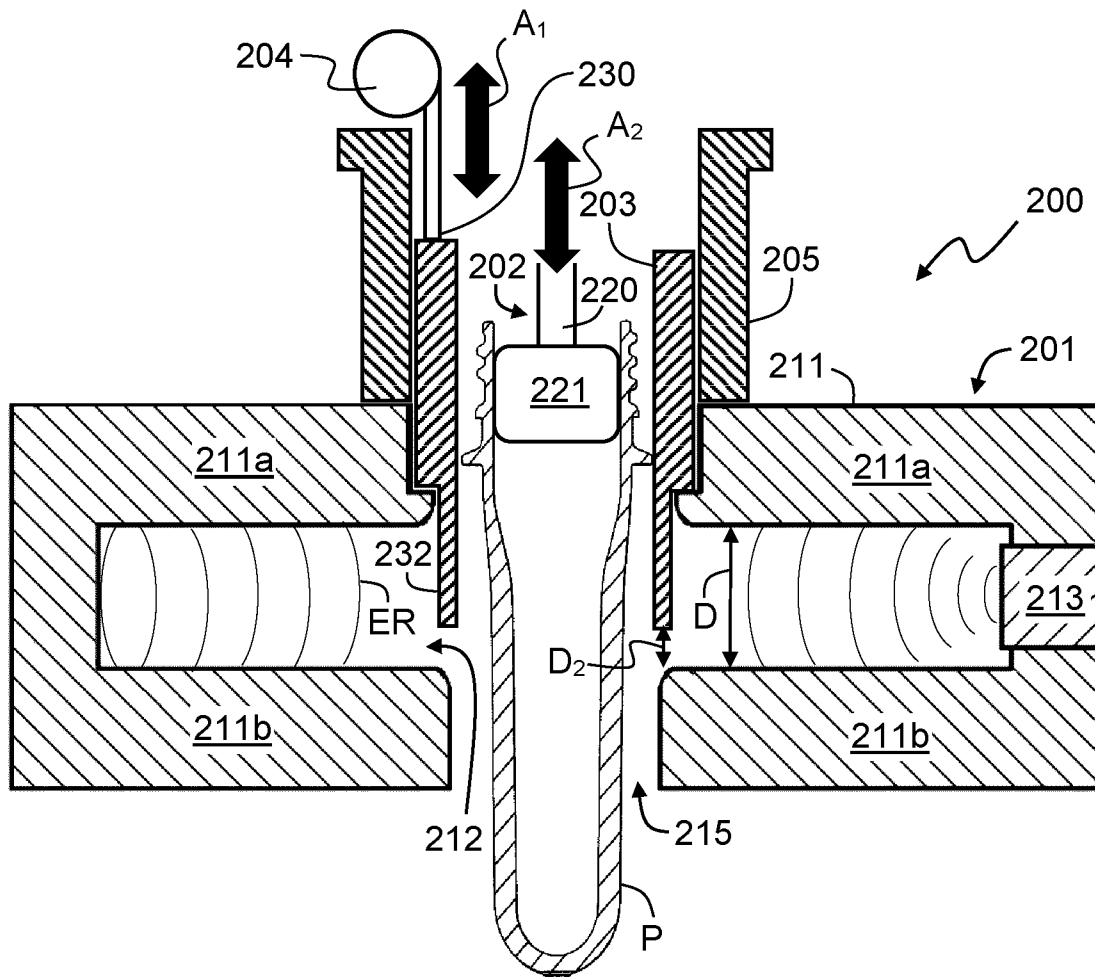


FIGURE 6

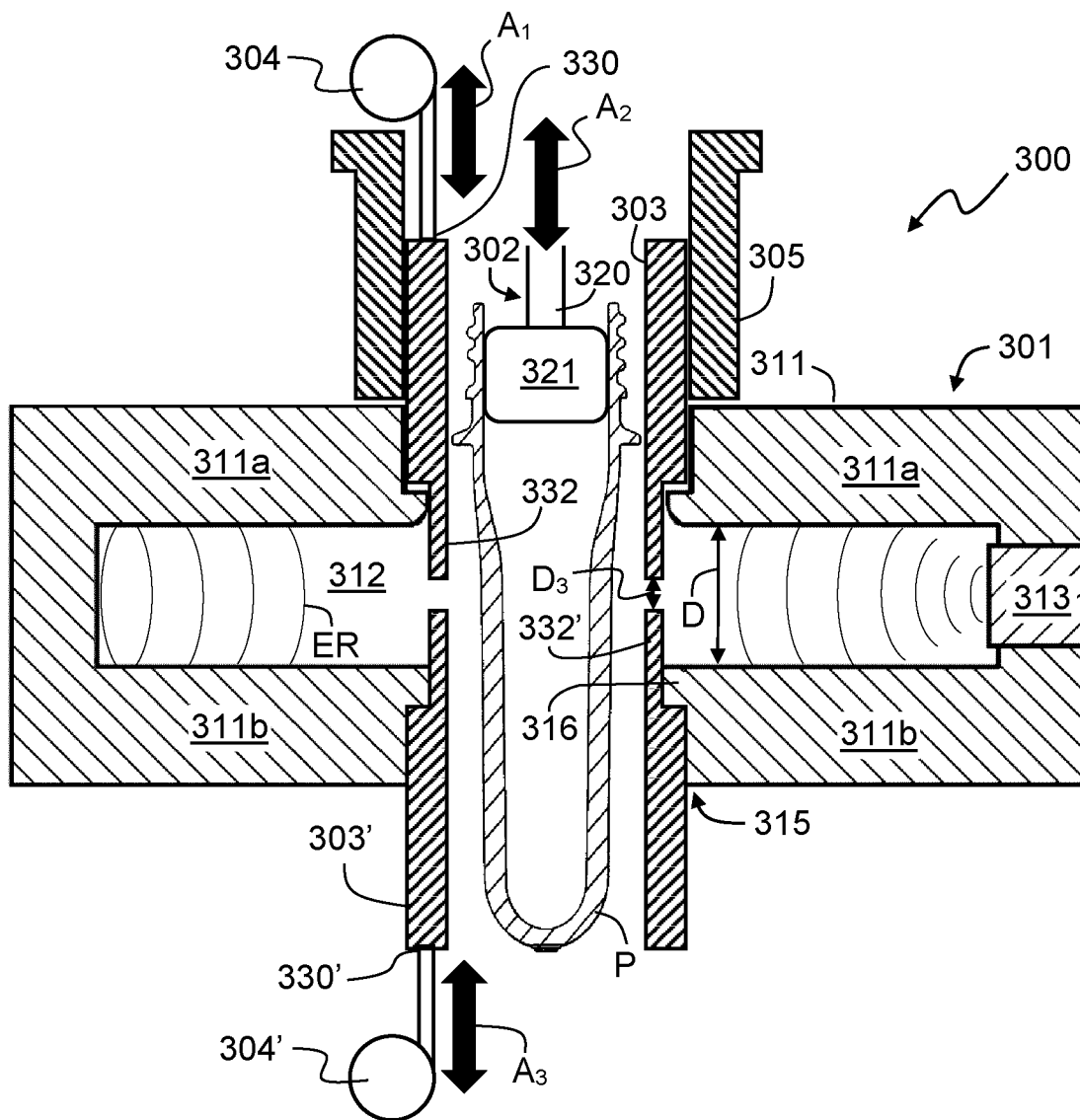


FIGURE 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA2023/051414

A. CLASSIFICATION OF SUBJECT MATTER

IPC: **B29B 13/02** (2006.01), **B29B 11/08** (2006.01), **B29B 11/12** (2006.01)

CPC: , B29B 11/08 (2020.01), B29B 11/12 (2020.01), B29B 13/02 (2020.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B29B 13/02 (2006.01), B29B 11/08 (2006.01), B29B 11/12 (2006.01)

CPC: B29B 11/08 (2020.01), B29B 11/12 (2020.01), B29B 13/02 (2020.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)

Database: Questel Orbit, fampat Keywords: screen+ or shroud+ or shield+ or surroun+ or block+ or sleev+ or tunin+, er or radiat+ or heat+ or electromag+ or irradiat+ or microwav+ or frequenc+ or infra+, preform+ or bottl+ or plastic+ or containe+, hold+ or mount+ or bracke+, resonator+, metalli+ or dielectri+ or ceramic+ or polmeri+ or transpar+, adjust+ or movab+ or chang+ or modif+ or axial+ or retract+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2016/207546 A1 (FEVRE, S. et al.) 29 December 2016 (29-12-2016) machine translation through Questel Orbit Website used for citation *entire document*	1-14, 20-23
Y, D	EP 2439047 A2 (WINZINGER, F.) 11 April 2012 (11-04-2012) machine translation through Questel Orbit Website used for citation *entire document*	1-14, 20-23
A	US 2008/0217326 A1 (ARMELLIN, A. et al.) 11 September 2008 (11-09-2008) *figs 5a and 5b, and ¶36*	1-23

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* "A" "D" "E" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance document cited by the applicant in the international application earlier application or patent but published on or after the international filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" "X" "Y" "&"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art document member of the same patent family
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Date of the actual completion of the international search
22 November 2023 (22-11-2023)Date of mailing of the international search report
12 January 2024 (12-01-2024)Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 819-953-2476

Authorized officer

Max Pelletier-Fortin

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA2023/051414

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10 2010 055 188 A1 (ZIMMERER, J. et al.) 12 July 2012 (12-07-2012) machine translation through Questel Orbit Website used for citation *24, and 26 of fig 6c*	15-19
A	WO 2011/039667 A1 (MONTEIX, S.) 7 April 2011 (07-04-2011) *entire document*	1-23

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2023/051414

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WO2011039667A1	07 April 2011 (07-04-2011)	EP2483046A1 EP2483046B1	08 August 2012 (08-08-2012) 13 November 2013 (13-11-2013)