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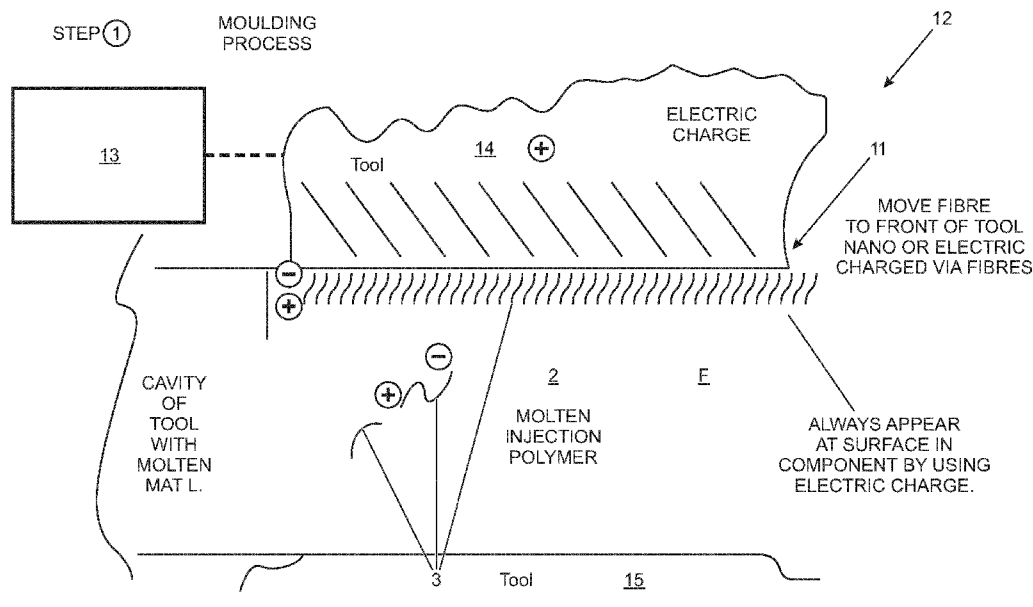


FIG. 3

(57) Abstract: The present disclosure relates to a moulding process for moulding a component (1; 5). A plastics material (2) having electrically charged fibres (3) dispersed therein is introduced into a mould cavity (11). An electric field (F) is generated in said mould cavity (11) to apply an electrostatic force to said electrically charged fibres (3) to modify their position and/or orientation. The present disclosure also relates to a component (1; 5); and to a mould (12).

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MOULDING PROCESS AND APPARATUS

TECHNICAL FIELD

The present disclosure relates to a moulding process and apparatus. Particularly, but not exclusively, the present disclosure relates to a moulding process for moulding a component from a plastics material comprising a plurality of fibres. The present disclosure also relates to a mould adapted to implement said moulding process.

BACKGROUND

Injection moulding processes are well known. The moulding process comprises a filling stage, a holding (packing) stage and a cooling stage. During the filling stage, the plastics material is injected into a mould cavity in a liquid state. The plastics material is injected at high pressure to ensure that the mould cavity is filled. During the holding (packing) stage, the plastics material in the mould cavity is held at a high pressure. The pressure in the mould cavity is reduced during the cooling stage and the plastics material cools in situ. The mould cavity is then opened and the component removed. It will be understood that there is limited scope to modify the properties of the plastics material forming the component.

At least in certain embodiments the present invention seeks to provide an improved moulding process and moulding apparatus.

SUMMARY OF THE INVENTION

Aspects of the present invention relate to a moulding process, to a component and to a mould.

According to a further aspect of the present invention there is provided a moulding process for moulding a component, the moulding process comprising:

introducing a plastics material into a mould cavity, wherein electrically charged fibres are dispersed in said plastics material wherein said electrically charged fibres comprise a conductive polymer; and

generating an electric field in said mould cavity to apply an electrostatic force to said electrically charged fibres to modify their position and/or orientation. The electric field is used to control the position and/or orientation of the fibres in the plastics material. The properties of the component can be altered by controlling the electric field during the moulding process. At least in certain embodiments, the electrically charged fibres align with the electric field during the moulding process. By modifying the position and/or orientation of the electrically charged fibres within the plastics material, the properties of the moulded component can be modified. The moulding process has particular application in the moulding of a component which is to

be welded to another component, for example using a flash welding technique. The electric field can be generated so as to draw the electrically charged fibres towards a joining surface of the component, i.e. towards a surface which will subsequently be joined to another component. In certain implementations, the application of the electric field may result in the electrically charged fibres being disposed at or proximal to the joining surface of the component. Alternatively, or in addition, the electrically charged fibres may adopt a particular orientation relative to said joining surface. For example, the electrically charged fibres may be arranged substantially parallel to or substantially perpendicular to the joining surface.

The plastics material may be introduced into said mould cavity in a liquid state. For example, the plastics material may be heated and introduced into the mould cavity in a molten state. The electric field may be generated while the plastics material is in said liquid state. The electric field may be applied prior to or concurrent with the introduction of the plastics material into the mould cavity. The electric field may be applied during a filling stage of the injection process. The electric field may be applied after introduction of said plastics material, for example after the mould cavity is filled with the plastics material. The electric field may be applied during a packing stage of the moulding process. The electric field applies an electrostatic force to said electrically charged fibres while they are suspended in the plastics material. While the plastics material is in said liquid state, the position and/or orientation of the electrically charged fibres may be influenced by the electric field. The position and/or orientation of the electrically charged fibres may be modified in localised regions or throughout the plastics material.

The plastics material may comprise or consist of a polymer. The polymer may be a high-performance engineering polymer, such as Polyethersulfone (PES) or Polyphenylene Sulphide (PPS); an engineering polymer, such as Polysulfone (PSU) or Polyethylene terephthalate (PET); or a standard polymer, such as Polyvinyl Chloride (PVC) or Polypropylene (PP). The polymer may have an amorphous structure or a semi-crystalline structure. The polymer may be a fibre reinforced polymer.

The electrically charged fibres may comprise or consist of one or more conductive polymer. The electrically charged fibres may comprise or consist of a conjugated conductive polymer. The electrically charged fibres may comprise or consist of an intrinsically conducting polymer. The electrically charged fibres may comprise or consist of thermoplastic polymeric electrically charged fibres.

The electrically charged fibres may comprise an additive. The additive may be incorporated into the fibres. Alternatively, or in addition, the additive may be applied as a coating to the fibres.

- 5 The additive may be electrically charged. The additive may have a positive or negative charge for interacting with the electric field generated in the mould cavity.

The additive may be a coloured additive, for example comprising a dye or pigment, or a coloured nano-particulate organic or inorganic material. The additive may be electrically
10 conductive. The additive may comprise or consist of carbon black.

The electrically charged fibres may comprise or consist of nanofibres. The nanofibres may comprise one or more polymeric materials, wherein at least one of said polymeric materials is electrically conductive. The nanofibres may comprise conjugated conducting polymers, and
15 derivatives and polymer blends including such materials. The nanofibres may be adapted to promote formation of a weld during a flash welding process. For example, the nanofibres may be composed of coloured, electric charge sensitive thermoplastic polymeric fibres or opaque polymers. The flash welding process may comprise generating a flash of light, for example using a laser or a camera flash, to induce melting and cross-linking of the nanofibres. It will be
20 understood that the frequency and/or intensity (power) of light emitted during a flash welding process may be adapted in dependence on the properties of the nanofibres. During the flash welding process, at least in certain embodiments the nanofibres may absorb thermal energy more efficiently than the plastics material, thereby enabling the weld to be formed without the need for prolonged heating.

25

The electric field may be generated by application of a direct current. The direct current may be applied to a mould tool forming said mould cavity. The mould tool may comprise an electrically conductive region. The electric field may be generated by applying the direct current to said electrically conductive region. The electrically conductive region may comprise
30 or consist of an electrode disposed in said mould tool. Alternatively, the mould tool may be composed of an electrically conductive material, such as steel or other metal.

The electrically charged fibres may have a positively charged first end and a negatively charged second end. The resulting electrostatic force would attract either the first end or the
35 second end of the fibres towards the source of the electric field. In arrangements in which the electric field is generated by applying an electric current to the mould tool, either the first end or the second end of the fibres may be drawn towards the mould tool. The fibres may be

disposed at or proximal to a surface of the component. The direct current may have a voltage which is less than or equal to 10V. The direct current may have a voltage which is approximately 1V.

- 5 The direct current may be applied to a portion of the mould tool defining a joining surface of the component. The joining surface of the component is configured to cooperate with a joining surface of another component. The joining surface may, for example, define a weld site or a weld profile area.
- 10 Alternatively, or in addition, the direct current may be applied to a region of the mould tool where separate melt fronts of the plastics material come into contact with each other. A join line may be formed in the component where the melt fronts join together. The join line may comprise or consist of a weld line (also known as a knit line) and/or a meld line. By generating an electric field in this region, the fibres dispersed in the plastics material may be positioned
- 15 and/or oriented so as to reinforce the join line. It is envisaged that some of the fibres may extend across the join line. The generation of the electric field in this region may promote formation of a meld line, as opposed to a weld line, between said melt fronts.

It will be appreciated that the moulding process described herein may be used to form both

20 two-dimensional and three-dimensional components.

According to a further aspect of the present invention there is provided a component formed by the moulding process described herein. The component may comprise a joining surface. The fibres may be concentrated in said plastics material proximal to said joining surface. In

25 other words, the density of fibres may be higher proximal to said joining surface than in other regions of the component.

The component may comprise a join line formed where the separate melt fronts come into contact with each other as the component is moulded in a mould cavity. The fibres may extend

30 across the join line. The join line may comprise or consist of a weld line and/or a meld line.

According to a further aspect of the present invention there is provided a mould for moulding a component, the mould comprising:

- a mould cavity; and
- 35 means for generating an electric field in said mould cavity. The mould is adapted to mould a plastics material comprising a plurality of electrically charged fibres. In use, the electric field in said mould cavity may apply an electrostatic force to the electrically charged

fibres to modify their position and/or orientation in the plastics material. The mould cavity may be formed by one or more mould tool. For example, a first mould tool and a second mould tool may cooperate with each other to form said mould cavity. The mould tool(s) may also be used as said electric field generating means. For example, an electric current may be supplied to at least one of said one or more mould tool to generate the electric field. Alternatively, or in addition, the electric field generating means may comprise at least one electrode. The at least one electrode may be connected to a direct current generator. The at least one electrode may be disposed proximal to a portion of the mould tool defining a joining surface of the component. The at least one electrode may be disposed proximal to a region of the mould tool where separate melt fronts of the plastics material come into contact with each other.

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 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. 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.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the present invention will now be described, by way of example only, with reference to the accompanying figures, in which:

Figure 1 shows a container comprising first and second components moulded in accordance with an embodiment of the present invention;

Figure 2 shows a perspective view of the first component shown in Figure 1;

Figure 3 is a schematic representation of the moulding process according to an embodiment of the present invention;

Figure 4 is a graph illustrating the cavity pressure during the moulding process according to an embodiment of the present invention; and

Figure 5 is a schematic representation of a flash welding process for joining the first and second components to form the container shown in Figure 1.

DETAILED DESCRIPTION

A process for moulding a first component 1 from a plastics material 2 in accordance with an embodiment of the present invention will now be described with reference to the

accompanying figures. The plastics material 2 comprises a polymer. A plurality of fibres 3 are dispersed throughout the plastics material 2. In the present embodiment the fibres 3 are nanofibres 3.

5 As shown in figure 1, the first component 1 is a sub-component of a container 4. The first component 1 is joined to a second component 5 using a flash welding process to form a joint J. As shown in figure 2, the first component 1 comprises a lower wall 6 and a sidewall 7. The sidewall 7 has a first flange 8 which defines a first joining surface 9 which is profiled to match a second joining surface 10 formed on the second component 5. As described herein, the first and second joining surfaces 9, 10 are joined to form the container 4. The container 4 in the present embodiment is a pressure vessel for use in a vehicle (not shown). The first and second components 1, 5 are both moulded using the moulding process described herein. For the sake of brevity, the moulding process will be described with reference to the first component 1.

15 The first component 1 is injection moulded in a mould cavity 11 formed in a mould 12. As shown in Figure 3, the mould 12 comprises a first mould tool 14 and a second mould tool 15 which co-operate with each other to define the mould cavity 11. The first and second mould tools 14, 15 are made of steel or other suitable material and are mounted in a moulding apparatus (not shown). The first mould tool 14 defines an interior of the first component 1; and the second mould tool 15 defines an exterior of the first component 1. An outer portion of the first mould tool 14 comprises a substantially continuous surface which defines the first joining surface 9. The moulding apparatus comprises an injection screw for injecting the plastics material 2 into the mould cavity 11; and a linear actuator for displacing the first mould tool 14 relative to the second mould tool 15. The first mould tool 14 is mounted to the linear actuator and is movable relative to the second mould tool 15 to open and close the mould cavity 11. In use, the moulding apparatus is operated to displace the first mould tool 14 relative to the second mould tool 15 to close the mould cavity 11. The plastics material 2 is heated above its melting temperature and injected into the mould cavity 11 in a liquid state by the injection screw. The plastics material 2 is introduced into the mould cavity 11 under pressure in accordance with conventional injection moulding techniques. The plastics material is allowed to cool in the mould cavity and the first mould tool 14 is displaced relative to the second mould tool 15 to open the mould cavity 11 and enable removal of the first component 1.

35 The nanofibres 3 are electrically charged. A first end of each nanofibre 3 has a positive electrical charge and a second end has a negative electrical charge. The electrical charge allows the position and/or orientation of the nanofibres 3 to be adjusted by establishing an electrical field F in the mould cavity 11. In the present embodiment the nanofibres 3 are formed

of an electrically conductive polymer. Alternatively, or in addition, the nanofibres 3 may comprise an additive. The additive may be applied to the nanofibres 3, for example to form a coating. The additive may be electrically conductive. A suitable additive is carbon black. The additive may optionally comprise a dye or colour pigment. The nanofibres 3 are dispersed
5 throughout the plastics material 2. The nanofibres 3 may, for example, be pre-mixed with the plastics material 2. Alternatively, the nanofibres 3 may be introduced during the injection process, for example introduced under pressure into the injection screw. In a further alternative, the nanofibres 3 may be introduced into the mould cavity 11 prior to injection of the plastics material 2.

10 The mould 12 is connected to a direct current (DC) generator 13. The DC generator 13 supplies direct current to the mould 12 in order to establish the electric field F for interacting with the nanofibres 3. In the present embodiment, the DC generator 13 is electrically connected to the first mould tool 14 and supplies a direct current of approximately 1V during
15 the moulding process. The first mould tool 14 functions as an electrode and the direct current establishes the electric field F. In a variant, one or more electrodes may be incorporated into the mould 12 to generate one or more localised electric field F. For example, an electrode may be incorporated into the mould 12 proximal to the outer portion of the first mould tool 14 which defines the first joining surface 9 of the first component 1. In use, the electric field F penetrates
20 into the mould cavity 11 and interacts with the nanofibres 3 in the plastics material 2. In particular, the electric field F applies an electrostatic force to the nanofibres 3 which adjusts the position and/or orientation of the nanofibres 3. The direct current is either positive or negative. The electric field F attracts the end of the nanofibres 3 having the opposite charge and repels the end of the nanofibres 3 having the same charge. Thus, the nanofibres 3 may
25 at least partially align with the local electric field F. In the present embodiment, the direct current is positive and the resulting electric field F attracts the (negatively charged) second end of each nanofibre 3 and repels the (positively charged) first end of each nanofibre 3. The electric field F is operative to bias the nanofibres 3 towards an orientation in which they are oriented substantially perpendicular to the first joining surface 9 defined by the first mould tool
30 14. The second mould tool 15 may optionally be connected to a second direct current (DC) generator to generate a second electric field. The second DC generator may supply a direct current to the second mould tool 15 having a polarity that is the same as or that is opposite to the direct current supplied to the first mould tool 14. The configuration of the mould 12 may be modified to change the position and/or orientation of the nanofibres 3 relative to the first joining
35 surface 9. For example, one or more electrode may be disposed laterally of the first joining surface 9 such that the electric field F is operative to bias the nanofibres 3 towards an

orientation in which they are oriented substantially parallel to the first joining surface 9 defined by the first mould tool 14.

The moulding process for forming the first component 1 will now be described with reference to Figures 3 and 4. The mould apparatus brings the first and second mould tools 14, 15 together to close the mould cavity 11. The plastics material 2 is heated above its melting temperature so as to undergo a phase change to a liquid state. The plastics material 2 is introduced into the mould cavity 11 in said liquid state. In order to ensure that the mould cavity 11 is filled, the plastics material 2 is introduced to the mould cavity 11 under pressure. The moulding process transitions from a filling stage to a holding (packing) stage during which the pressure in the mould cavity 11 is maintained by the injection screw. The pressure on the plastics material 2 in the mould cavity 11 is reduced by reversing the injection screw and the first component 1 is allowed to cool in the mould cavity 11. A graph 100 showing the pressure in the mould cavity 11 with respect to time for an exemplary moulding process is shown in Figure 4. A first time T1 corresponds to the filling time of the mould cavity 11; a second time T2 corresponds to the holding time; and a third time T3 corresponds to the cooling time. The cavity pressure increases as the plastics material 2 fills the mould cavity 11, peaking at approximately 70MPa.

The electric field F is applied during the moulding process in order to modify the position and/or orientation of the nanofibres 3. It will be understood that the position and/or orientation of the nanofibres 3 may be adjusted only while the plastics material 2 is in a liquid state. A direct current is supplied to the first mould tool 14 to generate the electric field F during the filling stage and/or the holding (packing) stage of the moulding process. The electric field F may attract at least some of the nanofibres 3 towards the first mould tool 14 while the plastics material 2 is in a molten state. At least some of the nanofibres 3 may be attracted towards the first joining surface 9 of the first component 1. As the plastics material 2 solidifies, the nanofibres 3 are fixed in position at or proximal to the inner surface of the first component 1. In particular, either the first end or the second end of the nanofibres 3 may be disposed at or proximal to the first joining surface 9. Furthermore, the nanofibres 3 may at least partially align with the electric field F. In the present embodiment, the direct current is supplied during the last few seconds of the holding (packing) stage to allow the nanofibres 3 to align in the direction as the electric field F. As illustrated in Figure 3, the electric field F aligns the nanofibres 3 at least substantially perpendicular to the inner surface of the first component 1. A particular advantage of the moulding process described herein is that the nanofibres 3 may be concentrated at or proximal to the first joining surface 9 of the first component 1.

It will be understood that the above moulding process is also used to form the second component 5. The first and second components 1, 5 may be joined together along said first and second joining surfaces 9, 10, for example using a plastic welding process. The moulding process described herein offers particular advantages during a flash welding process since the nanofibres 3 in the plastics material 2 are positioned at or proximal to the surface of the first and second components 1, 5 and may more readily absorb radiant energy from an external energy source. With reference to Figure 5, the flash welding process comprises energizing light generating means 16 to generate an intense burst of light incident on the first and second joining surfaces 9, 10 of the first and second components 1, 5. The light generating means 16 may, for example, comprise light emitting diodes (LEDs) or a laser. The radiant energy transmitted to the first and second joining surfaces 9, 10 at least substantially instantaneously melts the nanofibres 3 disposed at and/or proximal to the surface of the first and second joining surfaces 9, 10. The first and second components 1, 5 are then brought together and a pressure applied to form the joint J between the first and second joining surfaces 9, 10. The nanofibres 3 in the plastics material 2 may improve joint integrity. It will be appreciated that other forms of electromagnetic radiation may be transmitted to weld the first and second components 1, 5.

The electric field F may be generated to modify the position and/or orientation of the nanofibres 3 in order to provide other benefits. For example, the electric field F may be used to manipulate the nanofibres 3 to reduce the formation of a weld line and/or a meld line within the first component 1. It is known that a join line may form where separate melt fronts occur in the plastics material 2 within the mould cavity 11. The join line may comprise or consist of a weld line and/or a meld line. The melt fronts may occur as the plastics material 2 flows past an insert and/or an aperture within the mould cavity 11; and/or where plastics material 2 is introduced into the mould cavity 11 through more than one inlet. The formation of a weld line or a meld line typically depends on the meeting angle of the melt fronts; a weld line forms where the meeting angle is less than 135° and a meld line forms where the meeting angle is greater than 135° . The formation of meld lines and/or weld lines may adversely affect the strength and/or the appearance of the moulded component. The electric field F may be generated to attract the nanofibres 3 to a region where separate melt fronts may converge as the plastics material 2 is introduced into the mould cavity 11. At least in certain embodiments, the nanofibres 3 may extend across the weld lines and/or meld lines. Thus, the moulding process described herein may help to improve the strength and/or appearance of moulded components.

It will be understood that various changes and modifications may be made to the moulding process described herein without departing from the scope of the present invention. The moulding process described herein is performed on a plastics material 2 having nanofibres 3 dispersed therein. The techniques described herein may be applied to other types of fibres.

- 5 For example, the moulding process may be implemented on a plastics material having glass or carbon fibres dispersed therein. An electrically charged additive may be applied to the fibres to provide the required interaction with the electrostatic force generated by the electric field.

- 10 The embodiment of the present invention described herein comprises injecting into a mould cavity a plastics material having a plurality of fibres dispersed therein. In a variant, the fibres may be introduced into the mould cavity prior to the injection of the plastics material. An electric field may be generated in said mould cavity to control the position and/or orientation of the fibres in the plastics material.

CLAIMS:

1. A moulding process for moulding a component, the moulding process comprising:
introducing a plastics material into a mould cavity, wherein electrically charged fibres
5 are dispersed in said plastics material,
wherein said electrically charged fibres comprise a conductive polymer; and
generating an electric field (F) in said mould cavity to apply an electrostatic force to
said electrically charged fibres to modify their position and/or orientation.
- 10 2. A moulding process as claimed in claim 1, wherein the plastics material is introduced
into said mould cavity in a liquid state and the electric field (F) is generated while the plastics
material is in said liquid state.
3. A moulding process as claimed in claim 1 or claim 2, wherein said electrically charged
15 fibres consist of the conductive polymer.
4. A moulding process as claimed in any one of claims 1, 2 or 3, wherein said fibres
comprise an electrically conductive additive.
- 20 5. A moulding process as claimed in claim 4, wherein said electrically conductive
additive comprises carbon black.
6. A moulding process as claimed in any one of the preceding claims, wherein said
electrically charged fibres comprise nanofibres.
- 25 7. A moulding process as claimed in any one of the preceding claims, wherein said
electric field (F) is generated by application of a direct current.
8. A moulding process as claimed in claim 7, wherein said direct current is applied to a
30 mould tool forming said mould cavity.
9. A moulding process as claimed in claim 7 or claim 8, wherein said direct current has
a voltage which is less than or equal to 10V.
- 35 10. A moulding process as claimed in claim 8 or claim 9, wherein said direct current is
applied to a portion of the mould tool defining a joining surface of the component.

11. A moulding process as claimed in any one of claims 8, 9 or 10, wherein said direct current is applied to a region of the mould tool where separate melt fronts of the plastics material come into contact with each other.

5 12. A moulding process as claimed in any one of the preceding claims, wherein the electrically charged fibres have a positively charged first end and a negatively charged second end.

10 13. A component formed by the moulding process claimed in any one of the preceding claims.

14. A component as claimed in claim 13 when dependent directly or indirectly on claim 11, wherein the component comprises a joining surface and said fibres are concentrated in said plastics material proximal to said joining surface.

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15. A component as claimed in claim 13 or claim 14 when dependent directly or indirectly on claim 11, wherein the component comprises a join line where the separate melt fronts join together and said fibres extend across said join line.

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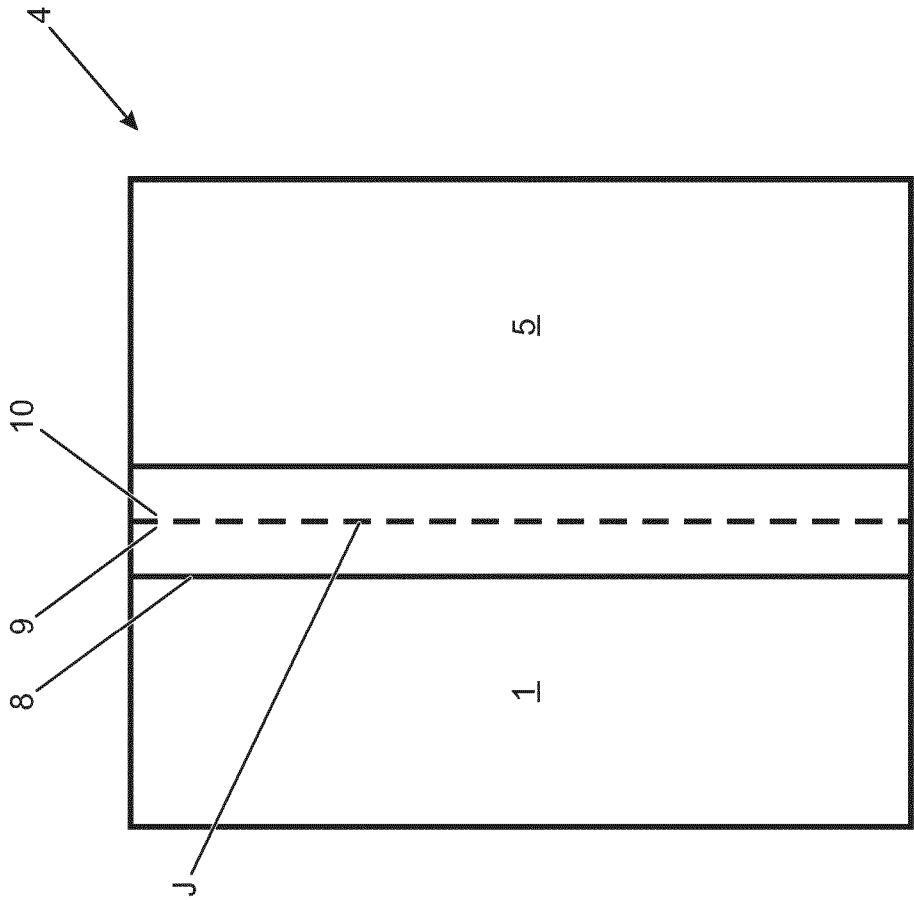


FIG. 1

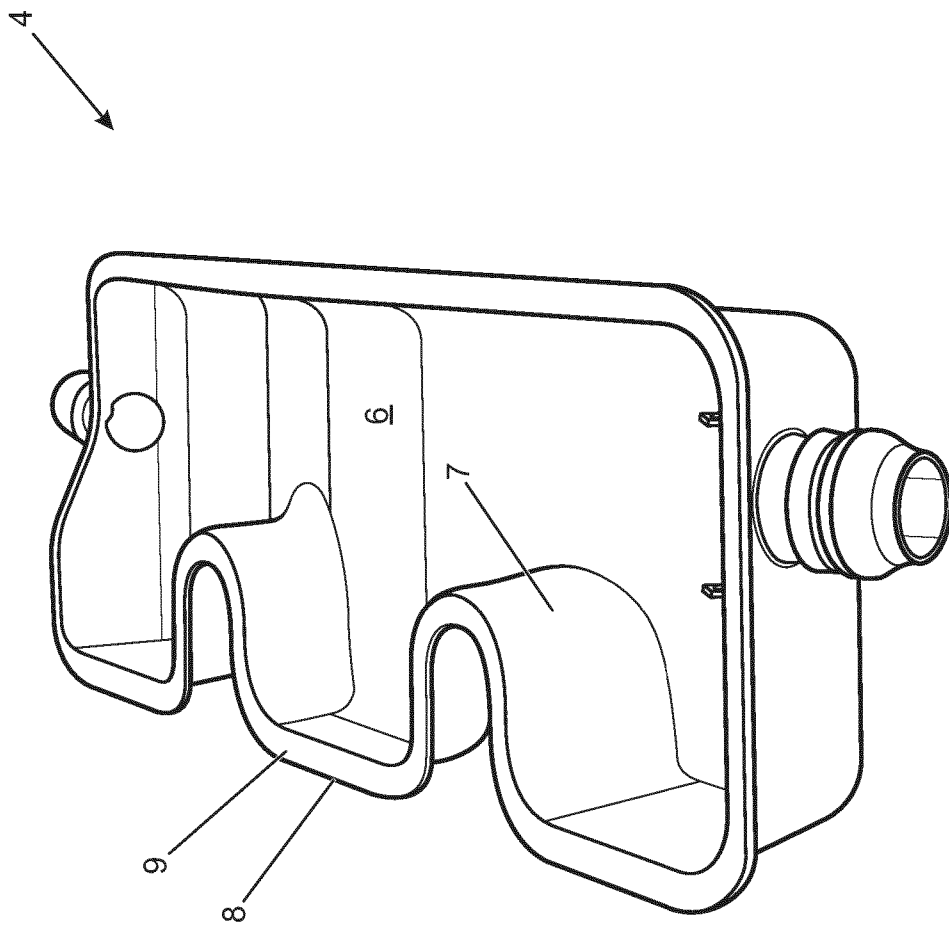


FIG. 2

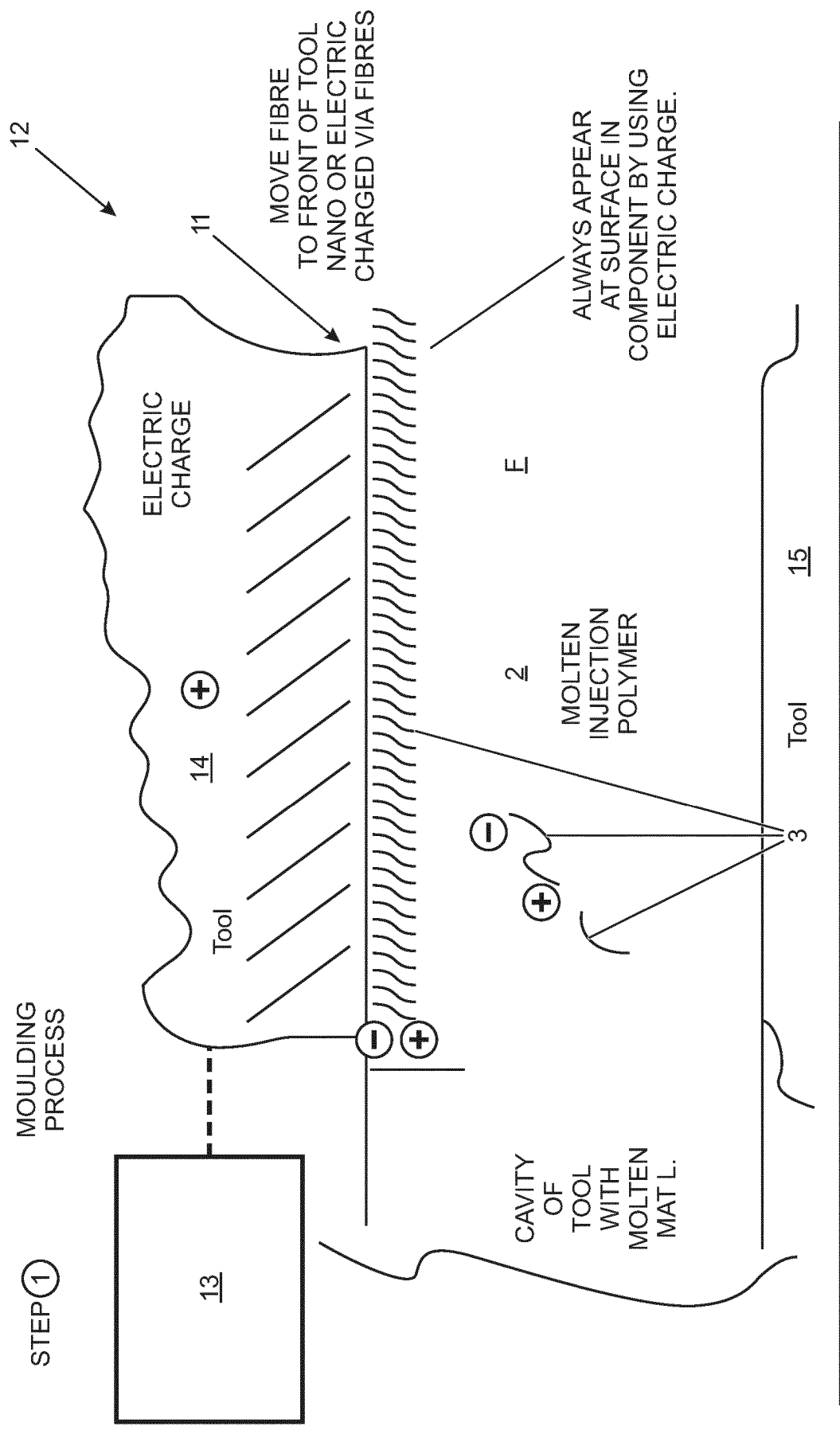


FIG. 3

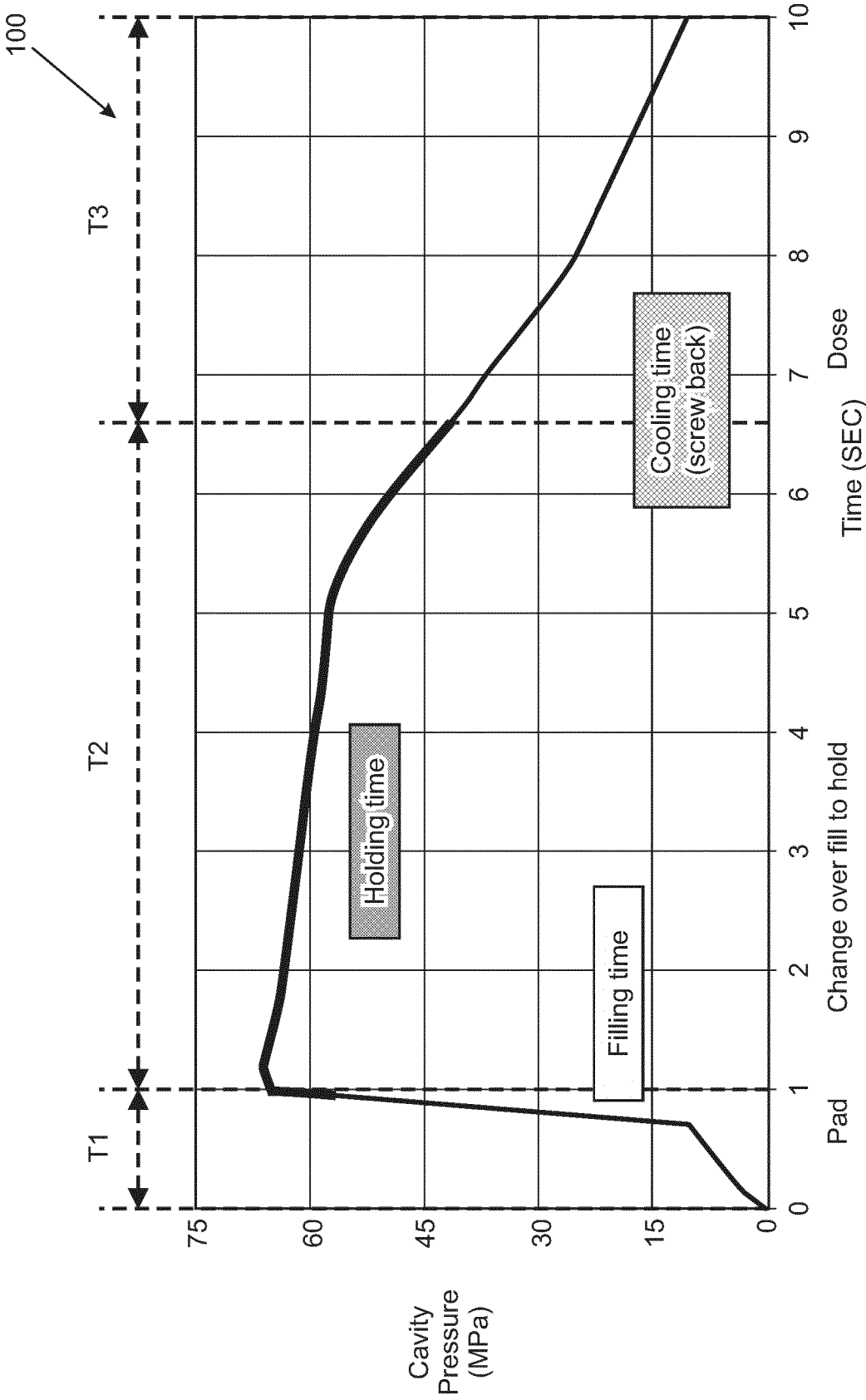


FIG. 4

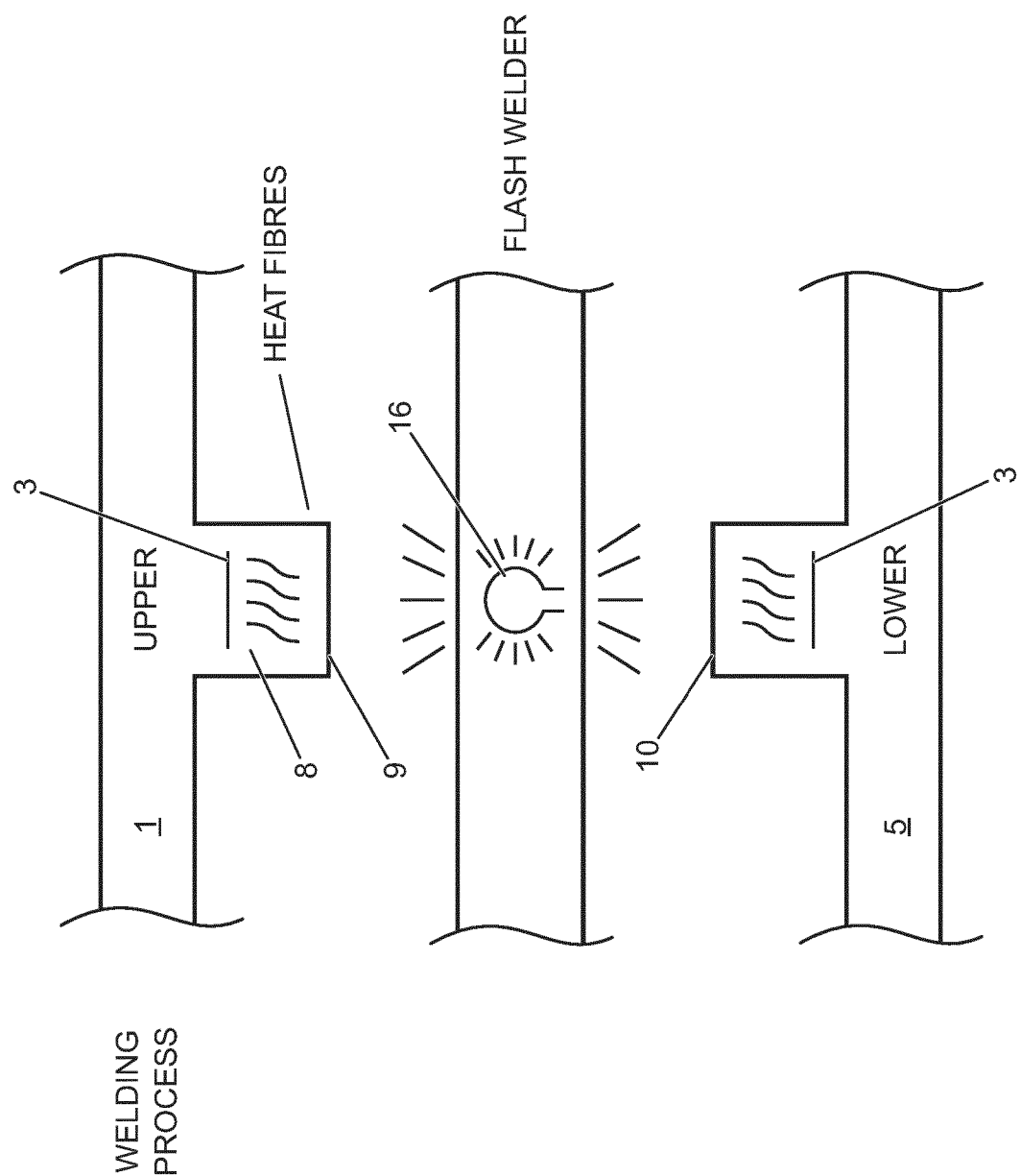


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079029

A. CLASSIFICATION OF SUBJECT MATTER INV. B29C70/88 B29C71/00 B29C70/14 B29C45/00 ADD. B29K105/00 B29K105/14														
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) B29C B29K														
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched														
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data														
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>US 2003/096104 A1 (TOBITA MASAYUKI [JP] ET AL) 22 May 2003 (2003-05-22) Nanotubes (abstract) -----</td> <td>3</td> </tr> <tr> <td>X</td> <td>US 2013/341837 A1 (GANDHI UMESH N [US]) 26 December 2013 (2013-12-26)</td> <td>1,2,13</td> </tr> <tr> <td>Y</td> <td>Fig.1 to 5 orientation under magnetic/electric field reference n. 32,34 -----</td> <td>3</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	US 2003/096104 A1 (TOBITA MASAYUKI [JP] ET AL) 22 May 2003 (2003-05-22) Nanotubes (abstract) -----	3	X	US 2013/341837 A1 (GANDHI UMESH N [US]) 26 December 2013 (2013-12-26)	1,2,13	Y	Fig.1 to 5 orientation under magnetic/electric field reference n. 32,34 -----	3
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X	US 2013/341837 A1 (GANDHI UMESH N [US]) 26 December 2013 (2013-12-26)	1,2,13												
Y	Fig.1 to 5 orientation under magnetic/electric field reference n. 32,34 -----	3												
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/079029

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003096104 A1	22-05-2003	JP 4697829 B2	08-06-2011
		JP 2002273741 A	25-09-2002
		US 2003096104 A1	22-05-2003

US 2013341837 A1	26-12-2013	JP 6013935 B2	25-10-2016
		JP 2014004820 A	16-01-2014
		US 2013341837 A1	26-12-2013
