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(54) Title: MACHINERY AND METHOD FOR INJECTION MOLDING HOLLOW ELEMENTS

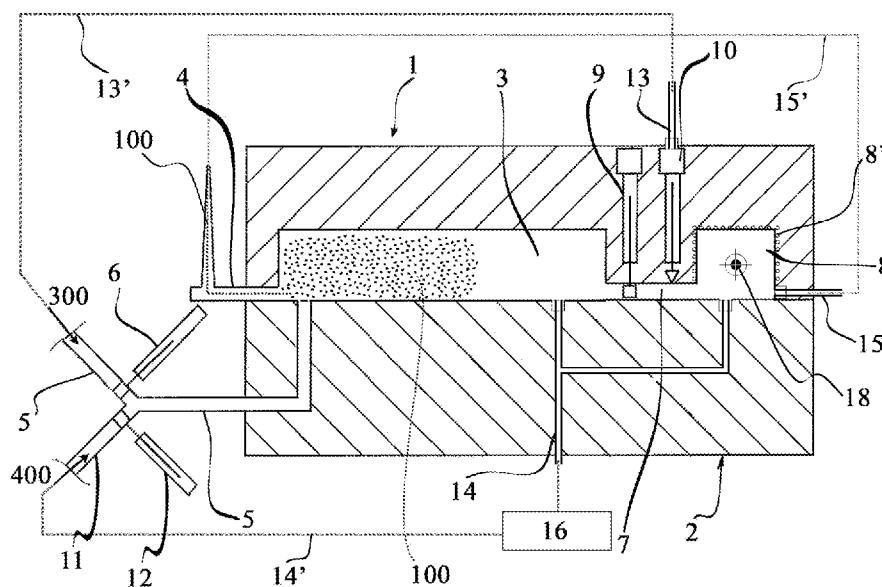


Fig. 1

(57) Abstract: Machinery for injection molding hollow elements, comprising a mold provided with: - feed duct (11) for feeding compressed air (400); - suction valve (13) and recycling duct (13') for the nitrogen (300); - suction valve (14) for suctioning the air from the interspace (3); operating according to a method comprising: (A) suctioning the air from the interspace (3), creating reduced pressure; (B) injecting the thermoplastic melt (100) in the interspace (3); (C) opening a valve (9) which connects the interspace (3) with the secondary space (8); (D) stopping the injection of the melt (100) and introducing nitrogen (300) in order to create a cavity (20) in the piece (200), up to the passage of the nitrogen (300) into the secondary space (8); (E) stopping the feeding of nitrogen (300) and simultaneous perforation of the piece (200) by means of a perforating element (10) for the outflow of the nitrogen (300) towards the suction valve (13) and its conveyance into the recycling duct (13') for reuse; (F) sixth step of feeding pressurized air (400) into the gas tube (5) for removing impurities from the cavity (20) of the molded piece (200) and for accelerating the solidification of the thermoplastic melt (100); (G) seventh step of opening the mold and of extracting the molded piece (200) that is by now solid.

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“Machinery and method for injection molding hollow elements”

Description

5 **Field of the art**

The present invention operates in the field of industrial processes for injection molding plastic materials. More in detail the present method is aimed for producing plastic elements that are entirely hollow.

10 **Prior art**

Numerous methods for injection molding internally hollow plastic elements are known at the current state of the art.

Among the prior art patents, US6713014 describes a process that is deemed the closest prior art. This regards a method and an apparatus for injection molding thermoplastic molded parts, having at least one cavity. The method comprises the following steps: a) injection of thermoplastic melt from an injection unit, along a melt flow path into the cavity of a mold; b) injection of a fluid into the still-liquid plastic material, such that the plastic material is pressed against the walls of the interspace; c) allowing the plastic material to cool up to forming the self-supporting shaped part and d) removing the molded part from the interspace of the mold.

The fluid used in the second step b) of the method can be water or a pressurized gas, preferably nitrogen.

Nevertheless, the use of nitrogen involves expenses due to its separation from the air and due to its maintenance at low temperature.

25 A further patent regarding the same field of the art is DE19505633, which describes a process for making hollow pieces of thermoplastic material that provides for the injection of the thermoplastic melt in the interspace of a mold and the simultaneous or subsequent injection of a pressurized fluid through one or more nozzles. Following cooling, the

pressurized fluid, which is preferably nitrogen, is released through one or more pressure release nozzles separated from the fluid injection nozzles, possibly collected in a recipient and reused.

There does not appear to be any patent that - for making a cavity in an object made of thermoplastic material - uses more than one fluid, in order to ensure the removal of possible impurities from the present cavity, as well as for the purpose of reducing the costs deriving from the exclusive use of nitrogen.

A first object of the present invention is therefore that of reducing the costs deriving from the use of nitrogen and other materials, recycling them as much as possible.

A second object of the present invention is to remove any impurity from the interspace within the just-produced hollow object.

Description of the invention

According to the present invention, a machinery and a method are proposed for making hollow elements by means of injection molding, which effectively solve the abovementioned problems.

The machinery comprises a mold constituted by a matrix and a cooperating punch, which in closed configuration describe an interspace having the external form of the object to be attained. Connected to the main interspace by means of connection duct, a secondary space is arranged in which the excess thermoplastic material melt is poured - i.e. that resulting from the internal excavation of the object. A valve is present in the connection duct that reversibly opens and closes based on the operating step.

In addition, in the connection duct, a perforating element is also arranged which is adapted to perforate the thermoplastic shell in order to allow the outflow of the nitrogen that forms, in one step of the method described in detail hereinbelow, the cavity in the obtained piece.

A gas introduction tube is connected to the main interspace of the mold and, depending on the current operating step, is adapted to convey nitrogen or compressed air within the interspace, which are coming from respective tanks and whose entrance in the mold is

regulated by corresponding valves.

To the above equipment pieces - which are known to the man skilled in the art for making internally hollow thermoplastic material elements - the equipment described hereinbelow is added, which cooperate with the obtainment of the aforesaid advantages:

- 5 - a feed duct for feeding compressed air controlled by a corresponding valve and advantageously flowing into the abovementioned gas tube;
- a first suction valve, placed at said perforating element, advantageously adapted to suction the nitrogen from the interior of the interspace and to introduce it into a first recycling duct adapted to transfer the gas from the interspace to the pressurized gas
10 feed tube in order to be advantageously reused in a subsequent molding cycle;
- a second suction valve, adapted to suction the air from the interspace and from the secondary space of said mold, creating reduced pressure useful for the first step of the method described hereinbelow.

The molding of a piece made of thermoplastic material, provided with a cavity, making use
15 of the machinery, object of the present invention, is carried out at least according to the following steps:

- (A) first step of suctioning the air from the interspace of the mold, by means of the activation of said second suction valve which creates reduced pressure in said interspace with respect to the external atmosphere. Such reduced pressure has the
20 advantage of facilitating the subsequent step of introduction of the melt, which fills the interspace in a quicker and more uniform manner;
- (B) second step of injecting the thermoplastic material melt in the interspace, by means of said nozzle, upon closure of the second air suction valve. In said second injection step, the second valve, which places the interspace in communication
25 with said secondary space, is closed;
- (C) third step of opening the second valve in order to place the interspace in communication with the secondary space;
- (D) fourth step of introducing nitrogen, which simultaneously comprises the stopping

of the injection of the melt and the opening of the first valve for feeding nitrogen in said interspace. In this step, the cavity is created which is provided within the piece under production. Advantageously, the nitrogen is introduced at a pressure such to also reach the secondary space;

5 (E) fifth step of stopping the feeding of nitrogen and simultaneous perforation of the piece being molded, in the section of the connection duct, by means of the perforating element. Advantageously, the nitrogen outflows at the first suction valve and is conveyed into the first recycling duct for its reuse in the following molding cycle;

10 (F) sixth step of feeding pressurized air into the gas tube, due to the opening of the second valve placed in the compressed air feed duct. Advantageously, due to this innovative step of the process, the impurities possibly present in the cavity of the piece are removed and the solidification of the thermoplastic melt is accelerated;

(G) seventh step of opening the mold and of extracting the molded piece, by now solid.

15 In several embodiments of the present machinery, a compressed air treatment device is advantageously also used, before such compressed air is introduced into the interspace of the mold. With this device, advantageously, the air can be introduced at the desired temperature and pressure and possibly also dried and purified.

Still more advantageously, it is possible to arrange a second recycling duct which, from the
20 air suction valve, conveys the suctioned air into the treatment device and then into the duct for feeding the compressed air into the interspace of the mold.

Beyond the recycling of the nitrogen and possibly also of the air, which already render the molding of hollow pieces decidedly less expensive than that done up to now, a recycling system for the thermoplastic melt can also be advantageously arranged by means of the
25 following devices:

- a system of heating elements, organized on the internal walls of the secondary space in order to maintain the thermoplastic material melt at the fluid state during the entire molding process;

- a third suction valve adapted to remove the thermoplastic melt at the fluid state from said secondary space and to convey it into a recycling duct which leads it back towards the introduction nozzle;
- a possible system of sensors adapted to monitor the complete emptying of the secondary space between one molding cycle and the next.

The advantages offered by the present invention are clear in light of the description set forth up to now and will be even clearer due to the enclosed figures and to the relative detailed description.

10 **Description of the figures**

The invention will now be described hereinbelow in at least one preferred embodiment as a non-limiting example, with the aid of the enclosed figures in which:

- FIGURE 1 shows a moment of the second step B of the present method;
- FIGURE 2 shows a moment of the third step C of the present method;
- 15 - FIGURE 3 shows a moment of the fourth step D of the present method;
- FIGURE 4 shows a moment of the fifth step E of the present method;
- FIGURE 5 shows a moment of the sixth step F of the present method;
- FIGURE 6 shows a moment of the seventh step G of the present method.

20 **Detailed description of the invention**

The present invention will now be illustrated as a merely non-limiting or non-binding example, with reference to the figures which illustrate the work steps of a mold according to a preferred embodiment of the present inventive concept.

With reference to all of the enclosed figures, a mold is shown that constitutes the central and essential part of the machinery of the present invention.

Like all known injection molds, this too is provided with a matrix 1 and with a punch 2 which, when arranged in a closed configuration, define an interspace 3 and a secondary space 8 connected by a connection duct 7.

Said interspace 3 is communicating on one side with a nozzle 4 for introducing thermoplastic material melt 100. On the same side, the interspace 3 is connected with a tube 5 for feeding pressurized gas which, due to a first valve 6, controls the introduction of nitrogen 300 into the interspace 3 of the mold.

- 5 At the connection duct 7, instead, the mold is provided with a second valve 9 which opens or closes the communication between the interspace 3 and the secondary space 8, and with a perforating element 10 which is adapted to perforate the piece 200 being molded up to attaining the cavity 20 thereof.

In addition to the above equipment pieces - by now known to the man skilled in the art - the
10 machinery of the preferred embodiment of the present invention is also provided with:

- a feed duct 11 for feeding compressed air, controlled by a third valve 12 and flowing into the gas feed tube 5;
- a first suction valve 13, placed at the perforating element 10, which suctions the nitrogen 300 from the interior of the interspace 3 and introduces it into a first recycling
15 duct 13', adapted to newly transfer the nitrogen 300 from the interior of the interspace 3 to the pressurized gas feed tube 5;
- an air treatment device 16 that regulates pressure, temperature, drying and purification of the pressurized air 400 to be fed within the mold;
- a second suction valve 14 that suctions the air from the interspace 3 and from the
20 secondary space 8 of the mold and introduces it into a second recycling duct 14', which leads it back to the air treatment device 16 and hence to be newly introduced into the interspace 3 in the subsequent molding cycle;
- a system of heating elements 8' on the internal walls of the secondary space 8 for maintaining the thermoplastic material melt 100 at the fluid state;
- 25 - a third suction valve 15, at said secondary space 8, for removing the thermoplastic melt 100 at the fluid state from the secondary space 8 itself, before the solidification and extraction of the piece 200 from the mold. The collected thermoplastic melt 100 is conveyed into a recycling duct 15' adapted to lead it back from secondary space 8 once

again towards the introduction nozzle 4;

- a system of sensors 18 in the secondary space 8 which monitor the completion of the emptying of the secondary space 8 between one molding cycle and the next.

With reference to FIG. 1, the second step of the method, object of the patent, is shown. In the first step A, due to the second air suction valve 14, slight reduced pressure was created in the interspace 3 of the mold which facilitates, in the second step of injecting the melt B, the entrance of the thermoplastic melt 100 from the nozzle 4 and its uniform and quick dispersion in the interspace 3.

In a third step C, illustrated in FIG. 2, the valve 9 is open and also the secondary space 8 is filled with thermoplastic melt 100 at the fluid state.

In FIG. 3, the fourth step D is shown for introducing the nitrogen 300 by means of the stopping of the injection of the melt 100 and the opening of the first valve 6 in the pressurized gas feed duct 5. In this step, the cavity 20 is created in the piece 200 under production and the nitrogen 300 opens a passage in the thermoplastic melt 100 up to attaining the secondary space 8.

In the fifth step E, shown in FIG. 4, the feeding of nitrogen 300 is interrupted and, simultaneously, the piece 200 is perforated in the section corresponding to the connection duct 7, by means of the perforating element 10. This allows the outflow of the nitrogen 300 towards the first suction valve 13 and its subsequent conveyance into the first recycling duct 13' for the reuse of the gas in the following molding cycle.

The sixth step F, shown in FIG. 5, provides for opening the second valve 12 in the feed duct 11 for feeding compressed air 400 and introducing the latter in the cavity 20 of the piece 200 for the removal of impurities therefrom and for accelerating the solidification of the thermoplastic melt 100.

Simultaneously, the system of heating elements 8' of the secondary space 8 keeps the melt 100 at the fluid state and the third suction valve 15 removes the melt 100 from the secondary space 8, conveying it into the corresponding recycling duct 15' which leads it back to the nozzle 4.

The seventh and last step G (FIG. 6) consists of opening the mold and extracting the molded piece 200, by now solidified with the cavity 20 thereof.

Finally, it is clear that modifications, additions or variations that are obvious for a man skilled in the art can be made to the invention described up to now, without departing from
5 the protective scope that is provided by the enclosed claims.

Claims

1. Machinery for injection molding hollow elements, comprising a mold constituted by a matrix (1) and by a cooperating punch (2), both of which delimit an interspace (3) on one side communicating with a nozzle (4) for the injection of thermoplastic material melt (100) and with a feed tube (5) for feeding pressurized gas, controlled by a first valve (6) for feeding nitrogen (300) inside said interspace (3), and on the other side with a connection duct (7) which places said interspace (3) in communication with a secondary space (8), a second valve (9) acting on the connection duct (7) for the closing and opening thereof, and a perforating element (10) also acting thereon which perforates a piece (200) in the connection duct (7), said machinery being **characterized in that** it also comprises:
 - a feed duct (11) for feeding pressurized gas, controlled by a third valve (12) and flowing into said gas tube (5), for feeding compressed air (400);
 - a first suction valve (13), placed at said perforating element (10), adapted to suction the nitrogen (300) from the interior of the interspace (3) of said mold and to introduce it into a first recycling duct (13') adapted to transfer said nitrogen (300) from the interior of said interspace (3) to said pressurized gas feed tube (5) in order to be reused in a subsequent molding cycle;
 - a second suction valve (14) adapted to suction the air from the interspace (3) and from the secondary space (8) of said mold, creating reduced pressure.
2. Method for injection molding hollow elements, **characterized in that** it uses the machinery of the preceding claim 1 and comprises the following steps:
 - (A) first step of suctioning the air from the interspace (3) of the mold, by means of the activation of said second suction valve (14) which creates reduced pressure in said interspace (3) with respect to the external atmosphere;
 - (B) second step of injecting the thermoplastic material melt (100) in said interspace

(3), by means of said nozzle (4), upon closure of said second suction air valve (14); in said second injection step (B), said second valve (9), which places the interspace (3) in communication with said secondary space (8), is closed;

5 (C) third step of opening the second valve (9) for placing said interspace (3) in communication with the secondary space (8);

(D) fourth step of introducing nitrogen (300) which simultaneously comprises the stopping of the injection of the melt (100) and the opening of the first valve (6) for feeding nitrogen (300) into said interspace (3) in order to create a cavity (20) in the piece (200) under production, up to the passage of the nitrogen (300) into the
10 secondary space (8);

(E) fifth step of stopping the feeding of nitrogen (300) and simultaneous perforation of the piece (200) being molded in the section of the connection duct (7) by means of the perforating element (10), for the outflow of the nitrogen (300) towards said first suction valve (13) and its subsequent conveyance into said first recycling duct (13') for the reuse of the nitrogen (300);
15

(F) sixth step of feeding pressurized air (400) into said gas tube (5) for removing impurities from the cavity (20) of the molded piece (200) and for accelerating the solidification of the thermoplastic melt (100);

(G) seventh step of opening the mold and of extracting the molded piece (200) that is
20 by now solid.

3. Machinery and method for injection molding hollow elements, according to the preceding claims 1 and 2, **characterized in that** the pressurized air (400) which is fed in said sixth feed step (F) is previously treated in a suitable device (16) adapted to allow the
25 introduction of the air (400) at a pre-established pressure and temperature.

4. Machinery and method for injection molding hollow elements, according to the preceding claim 3, **characterized in that** said air treatment device (16) is adapted to dry

and purify the pressurized air (400) to be fed inside the mold.

5. Machinery and method for injection molding hollow elements, according to the preceding claim 3, or 4, **characterized in that** said second air suction valve (14) is adapted to introduce the suctioned air into a second recycling duct (14') which conducts it to said air treatment device (16) and hence to be newly introduced into the interspace (3).
6. Machinery and method for injection molding hollow elements, according to any one of the preceding claims, **characterized in that** the walls of said secondary space (8) are provided with a system of heating elements (8') adapted to maintain the thermoplastic material melt (100) at the fluid state.
7. Machinery and method for injection molding hollow elements, according to the preceding claim 6, **characterized in that** said secondary space (8) is provided with a third suction valve (15) adapted to remove the thermoplastic melt (100) at the fluid state from said secondary space (8) before the solidification and extraction of the piece (200) from the mold.
8. Machinery and method for injection molding hollow elements, according to the preceding claim 7, **characterized in that** from said third suction valve (15), the thermoplastic melt (100) is conveyed in a recycling duct (15') adapted to lead the melt (100) collected from the secondary space (8) back towards the introduction nozzle (4).
9. Machinery and method for injection molding hollow elements, according to the preceding claim 7, or 8, **characterized in that** said secondary space (8) is provided with a system of sensors (18) adapted to monitor the complete emptying of the secondary space (8) between one molding cycle and the next.

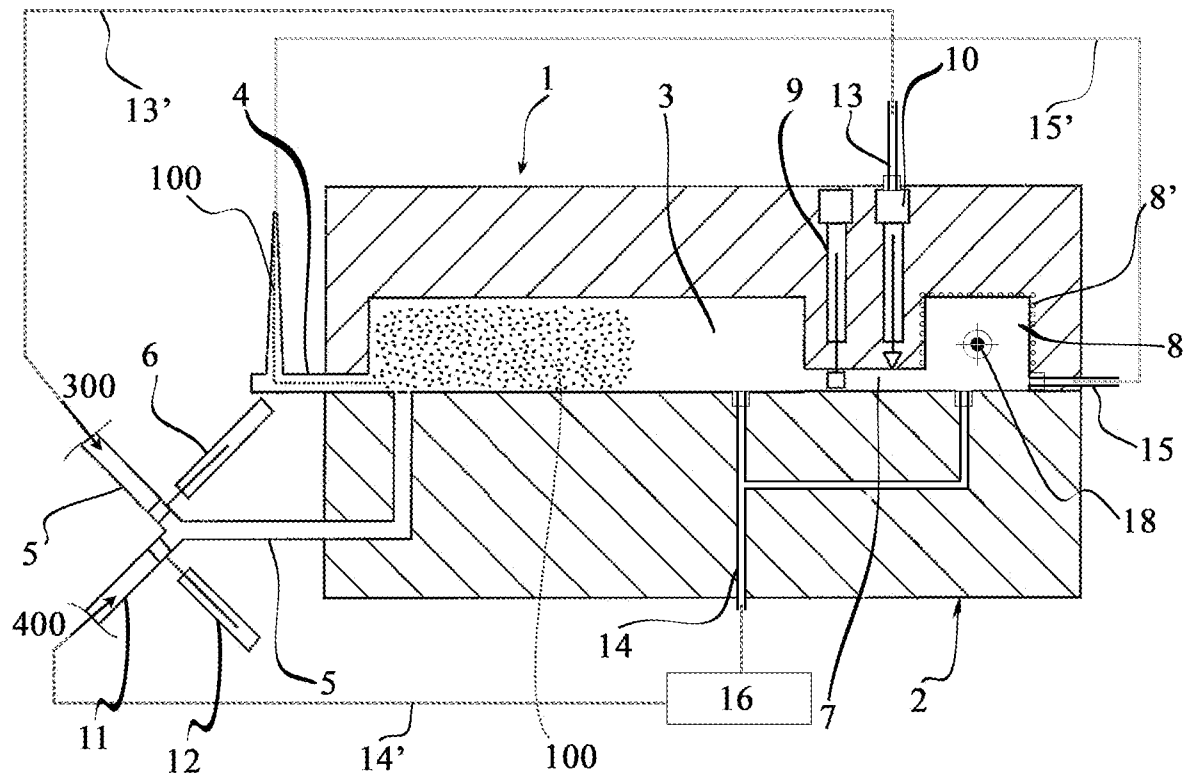


Fig. 1

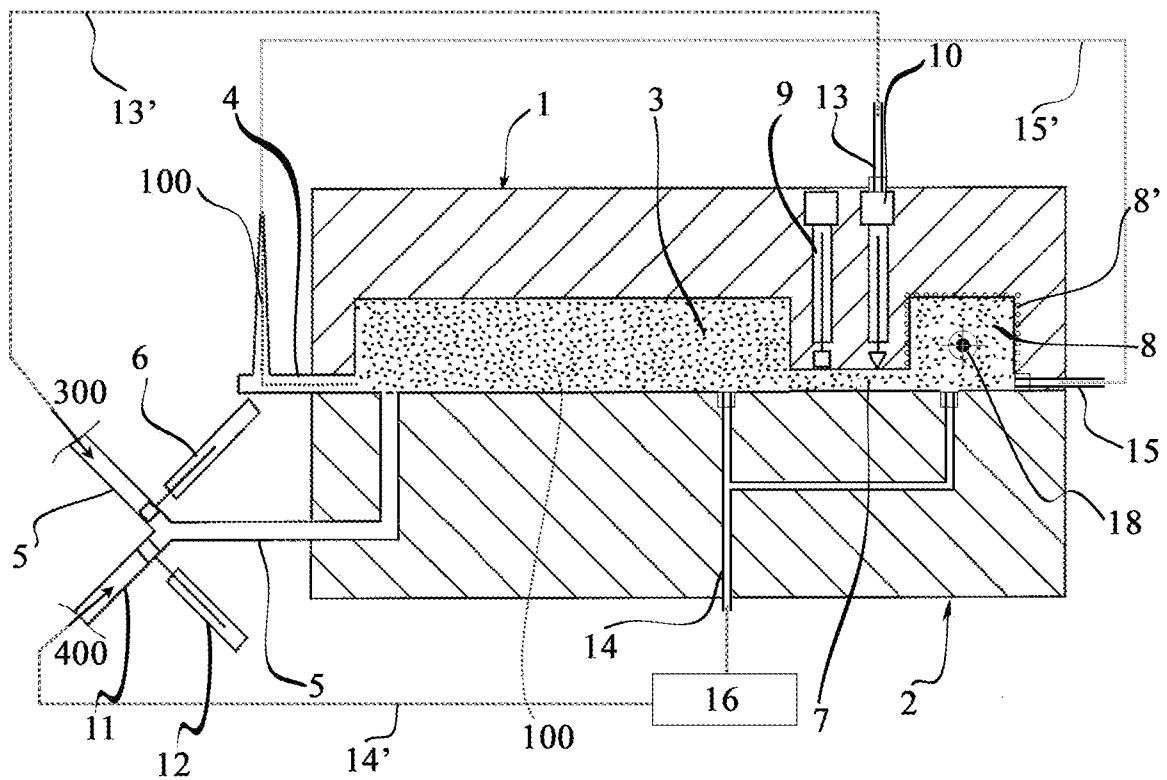


Fig. 2

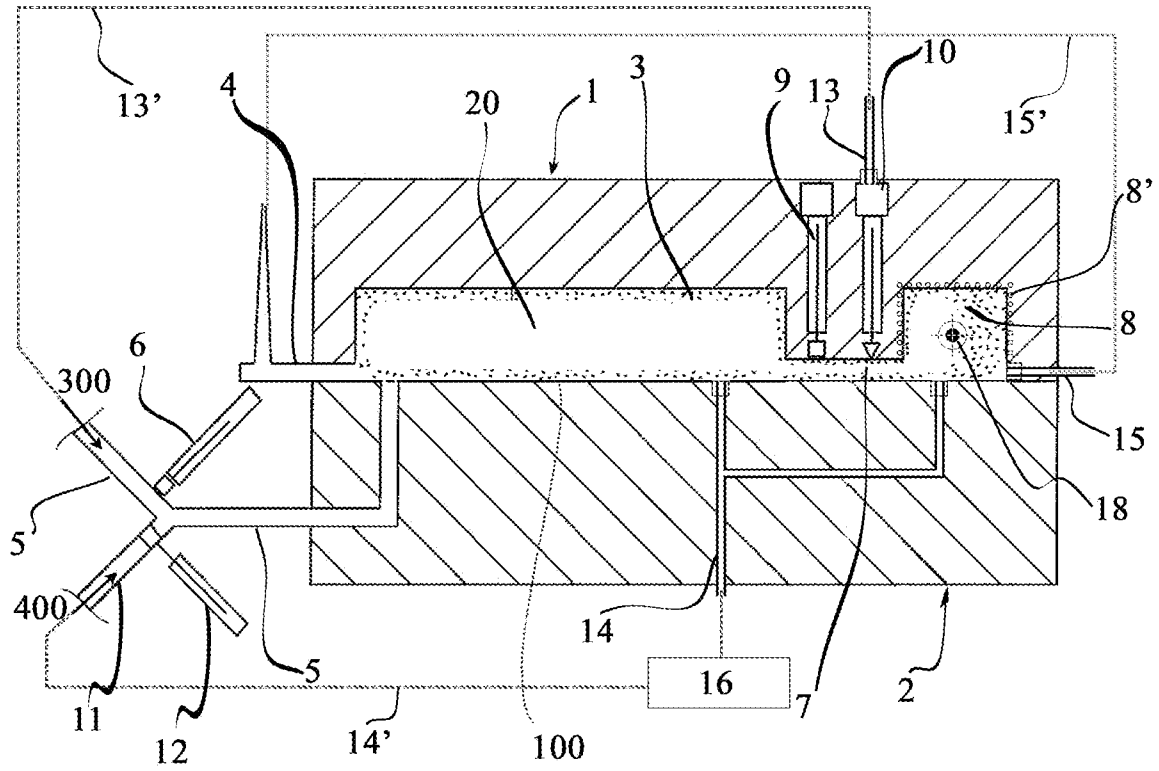


Fig. 3

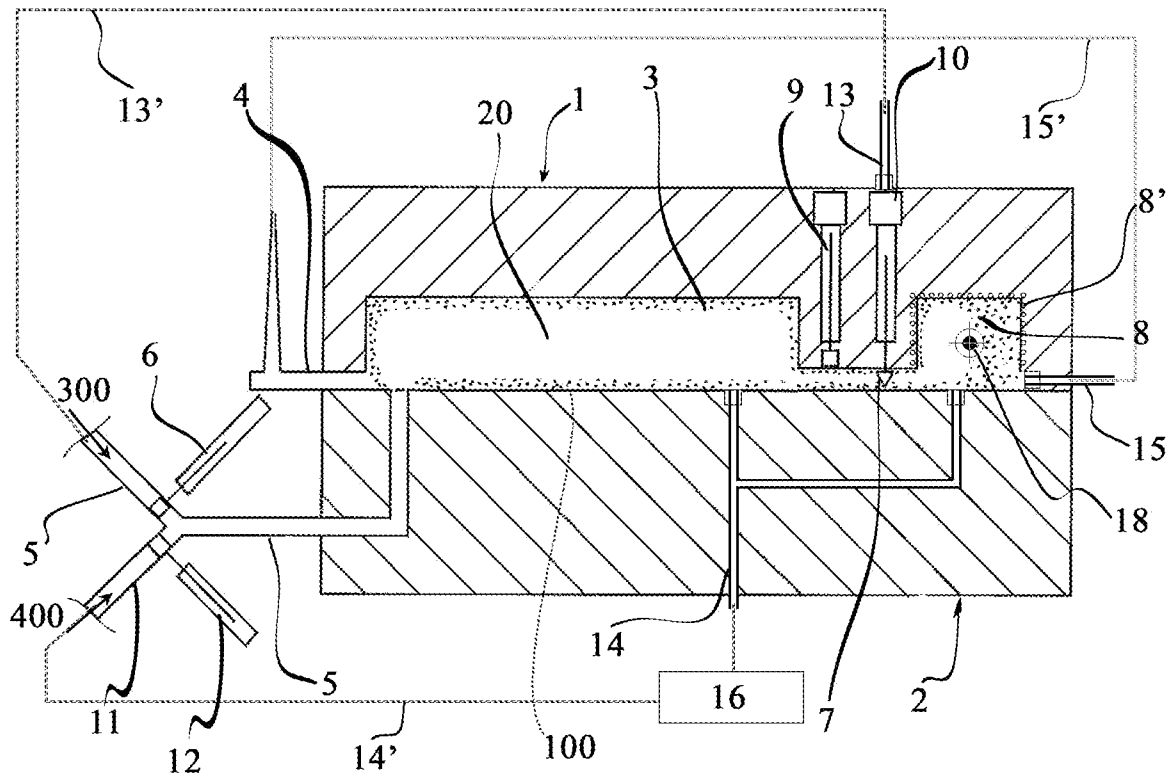


Fig. 4

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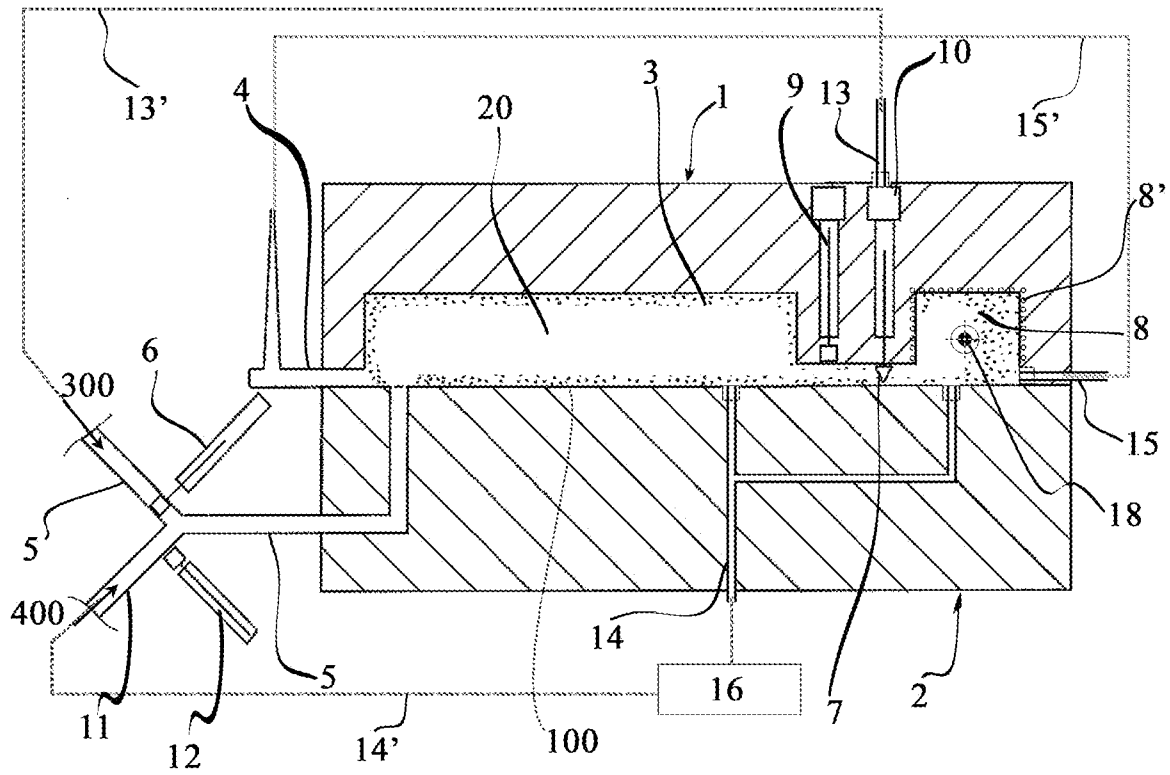


Fig. 5

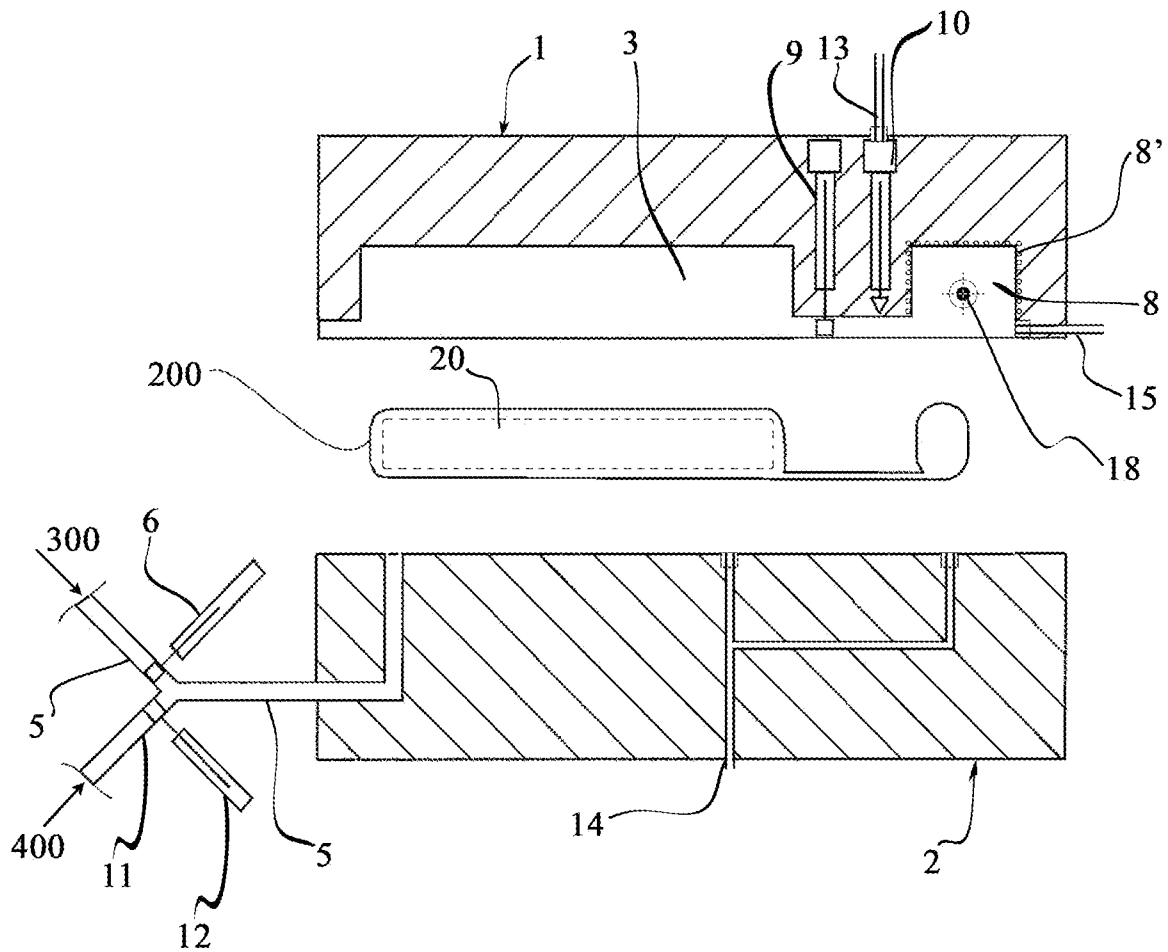


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/050863

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C45/17 B29C45/34
ADD.

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

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)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

14 March 2019

Date of mailing of the international search report

21/03/2019

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Brunswick, André

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/050863

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	abstract; figures 1, 3, 5, 6 paragraph [0008] - paragraph [0016] -----	5
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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